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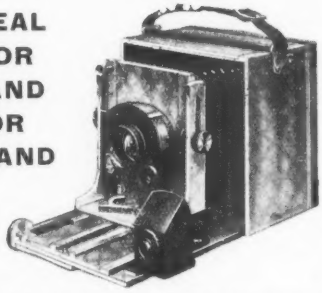

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The
GEOGRAPHICAL JOURNAL

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A TOPOGRAPHICAL STUDY OF THE FLOOD-SWEPT COURSE OF THE PORTH LLWYD ABOVE DOLGARROG: *A paper read at the Meeting of the Society on 26 March 1928, by*

PROFESSOR W. G. FEARNSIDES, F.G.S., M.I.MIN.E.,
AND W. H. WILCOCKSON, F.G.S.

AT the Oxford Meeting of the British Association, Dr. Edward Greenly, V.P.G.S., called the attention of Section C to the opportunity which the bursting of dams above Dolgarrog afforded for securing a complete record of notable changes of topography, which had been produced by the flow of a determinate amount of water along a British river's course. A Committee, consisting of Professor P. G. H. Boswell, Mr. I. S. Double, Professor W. G. Fearnsides, and Mr. E. Montag, with Dr. Greenly as Chairman, was appointed "to obtain photographic records of the geological effects of the *débâcle*," and its short report, drawn up by the Secretary, Mr. E. Montag, was presented at the Leeds Meeting of the British Association in 1927.

The field observations detailed below were made by the Authors jointly during the late summer of 1926 and the spring and autumn of 1927. The description of the flood-swept area from the broken exit of Llyn Eigiau, along the Afon Porth Llwyd stream-course, to Dolgarrog, has been written by Professor Fearnsides. The "photographic record" is the work of Mr. Wilcockson. A folding map of the district follows p. 496.

Engineers and public authorities have already considered the effects of the disaster, in so far as these have affected the handiwork of man; and the present communication deals only with corrasion and transport of material which was so placed by nature that it met the unusual rush of waters released by the failure of artificial barriers.

In order to obtain an estimate of the rate at which the waters were released, authoritative information concerning the general plan of concentration and storage of the run-off from the hills, for the power station at Dolgarrog, was necessary; and this has been supplied by the consulting engineers* to the

*The Consulting Engineers to the Aluminium Corporation are Messrs. Sir Douglas Fox and Partners, of Westminster, and to Mr. Ralph Freeman, M.INST.C.E., Senior Partner of that firm, our personal thanks are due. It is only right to say that neither Mr. Freeman, nor any other member of his firm, was in any way responsible for the original construction of the dam beneath which the flood waters escaped from Llyn Eigiau.

Aluminium Corporation, to whom the authors desire to return their very grateful thanks.

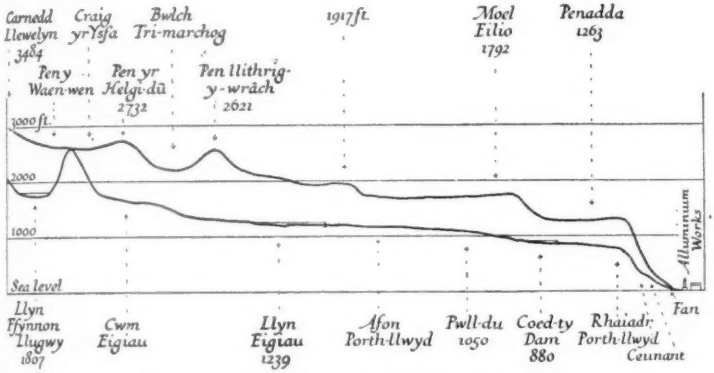
Dolgarrog is the site of the Hydro-Electric Generating Station to which is led the run-off from some 12 square miles of upland on the south-east slopes of the Carnedd group of mountains in North-East Carnarvonshire. The Afon Porth Llwyd is the trunk stream of the drainage system flowing eastwards from the Carnedds, which, by bringing in leats, has been augmented and diverted to supply the needs of the Dolgarrog Power Station. Porth Llwyd was the hamlet at the mouth of the Afon Porth Llwyd gorge which was obliterated when, consequent upon the development of a passage through boulder-clay beneath the concrete wall built to raise the level of Llyn Eigiau, the retaining bank of the lower reservoir at Coed-ty was swept out and the disastrous flood of November 1925 descended.

For the massive grandeur of its scenery, as also for extent of area above the 3000-feet contour, there is no hill-group in Southern Britain which can match the Carnedds. It is the most north-easterly member of the aligned hill masses which are the outcrop of the Ordovician volcanic outpourings and igneous intrusions of Snowdonia. The rise of its ridge line in 7 miles, from the coast at Conway to the 3091-foot summit of Y Foel Fras, is almost continuous, and thereafter, beyond Foel Graich (3195 feet), Carnedd Llewellyn (3484 feet), Carnedd Dafydd (3426 feet), and Pen yr Oleu Wen (3169 feet), the height of its lumpy ridge does not fall below 2900 feet for a farther distance of 5 miles, until, at the shoulder of Braich Ddu, it overlooks the bend of the Ogwen river into Nant Ffrancon, three-quarters of a mile distant and over 2000 feet below.

Not only are the Carnedd mountains big and high, but they are set upon a pediment, whose edges rise steeply from the North Welsh Coast, and even more abruptly from the tidal Conway on its eastern flank. The north-west-facing slopes have forms quite proper to the escarpment of a complex slab of igneous rock. The eastern slopes, which might have been the dip-slope, are bitten into by streams whose first base-level is the uplifted surface of the pediment; and whose courses, having started south-eastward along the dip of the rocks, turn seriatim along the general strike of minor folds or pitching corrugations which have disturbed the strata, and continue in parallel courses north-eastwards to the Conway or south-westwards to the Llugwy and the line of Telford's road. So steep is the edge of the pediment on its eastern side that on the truncated spurs which divide the river catchments as they come to join the Conway, the 1000-feet contour is within 1000 yards of the road which follows the edge of the tidal alluvium; and the several stream-courses hang so effectively that in cascade, rhaiadr, and pistill, they make their final descent from above the 1000-feet contour to sea-level within a distance of 2 miles. These conditions, in a region where soil is scarce and rainfall comparatively high, do not favour intensive occupation of the land, and as valuable mineral is scarce or absent, the native wealth of the country is in the water-power, developed by constraining the waters during their descent over the almost precipitous edge of the pediment.

The recent glacial history of the country has favoured the harnessing of the waters, for during the Pleistocene period this part of North Wales was very

intensely glaciated. Within the range of the Dolgarrog Power-house two quite large lakes, Cowlyd and Eigiau, and three mountain tarns, Dulyn, Melyn Llyn, and Fynnon Llugwy, each in its glacial corrie, were left when the glaciers melted, and provide natural water storage which has since been added to and improved by man. The three corrie lakes occur just under the Carnedd mountain ridge, more than 1700 feet above sea-level. The two large lakes lie also conveniently high: Eigiau above, and Cowlyd about the 1200-feet level. Llyn Cowlyd is situate near the watershed along a through south-west—north-east valley, but though large, has a restricted natural catchment. Llyn Eigiau is contained by a bank of moraine in front of a steep lateral crag where the large Cwm Eigiau widens abruptly. From it the waters flow directly as the main trunk feeder of the Porth Llwyd River. Above the 1500-feet level glaciation has left the country rocky and very bare, but over wide areas where ice from the corries spread out over the more open high valleys of the pediment, thick deposits of drift, much of it a very stony boulder-clay, accumu-



Section along the course of the Porth Llwyd

lated, so that between the 1250 and the 1000-feet contours one can walk for miles without ever touching solid rock. The steep truncated spurs of the left bank of the Conway have also been scored by glaciers, but above 300 feet O.D. these cliffs are mostly bare. Below that level along the spurs, and at every sort of level in the sheltered enclaves through which come streams from the hanging valleys, great banks of stiff ungraded boulder-clay, including numerous quite enormous ice-worn boulders, are plastered hard against the rock.

The Dolgarrog Hydro-Electric Power Scheme

The harnessing of the waters for the Dolgarrog Power Station began just over twenty years ago with the construction of a pair of leats which brought water from the Afon Porth Llwyd and the Afon Ddu round the eastern spur of Moel Eilio to a fore-bay with penstocks about 1000 feet above sea-level 300 yards south-west of the present Dolgarrog Works. Llyn Cowlyd, higher up the Afon Ddu than the intake of the Cowlyd leat, had already been ex-

tended and deepened to store and supply water to the joint Water Board for Conway and Colwyn Bay, so that leat got only the surplus run-off from the river at 1060 feet. The Eigiau or north branch leat from 1050 feet on the Afon Porth Llwyd at Pwll Ddu, brought the main feeder, and continuity of its supply was secured by extending and deepening Llyn Eigiau by 20 feet, by the erection of the 200-yard-long concrete dam across the exit stream, and half a mile of concrete wall along the crest of the bank of boulder-clay which forms the east side of the lake. That work was completed about 1910.

Subsequently the demand for energy from Dolgarrog has increased greatly, and in more recent years steps have been taken to meet it. A tunnel fed by leats at about 1300 feet allows so much of the water from the catchment of the Afon Dulyn as is not stored or drawn off from Llyn Dulyn by the Llandudno Water Board, to pass under the spur of Clogwyn yr Eryr to Llyn Eigiau. The level of Ffynnon Llugwy has been raised by a dam, and a long leat brings the water from the Afon Llugwy at about 1500 feet; and, collecting the catchment from the south slopes round Pen yr Helig and Pen Llithrig, conducts it, with water collected from the south slopes of Creigiau y Gleision, through the pass to Llyn Cowlyd, whose level has been raised by 40 feet to over 1200 feet by building a new earthwork dam. Furthermore, a new low-level reservoir was made by the construction of an earth bank across the flat of the Afon Porth Llwyd valley at Coed-ty, half a mile above the falls, and a new set of low-level leats about the 850-feet level collect the spills from the old leat about 1000 feet, and additional run-off from the lower slopes as far down as the edge of the pediment in both the Afon Porth Llwyd and the Afon Ddu valleys. All this low-level run-off was taken by a new pipe-line from the Coed-ty dam to the top of the steep pitch about 750 feet above sea-level, and thence alongside the old pipe-line directly to the Dolgarrog Works.

Most recently a new mile-long tunnel has been completed under the Cribiau (north-eastern) spur of Pen Llithrig, and soon excess of water from Llyn Eigiau will be sent through it for storage in the extended Llyn Cowlyd. When all these improvements are in operation, the 9 miles of constructed leat and the available high-level water-storage capacity exceeding 600 million cubic feet should ensure that the Dolgarrog Power Station will be able to make full use of the rainfall on the area which feeds the reservoirs.

The Bursting of the Eigiau Wall

Llyn Eigiau occupies a hollow at the foot of the 1000-feet-high cliffs of dolerite, Craig Eigiau. The crags are magnificent; but the stream from Cwm Eigiau enters at the south end of the lake without visible sign of a rock step, and there is no suggestion that the lake fills a rock basin. On the contrary, along its eastern edge it is retained by a broad swell or low bank of boulder-clay, full of great ice-worn stones, and more like a drumlin of ground-moraine than either lateral or terminal moraine material. The concrete wall constructed between 1907 and 1910 to increase the lake's capacity was founded upon this drift bank, and it was at a point some 1000 feet north of the corner of the wall, at a low saddle where the upstanding wall was about 20 feet high, that the outburst which caused the flood occurred.

Over almost all the gentle slopes and flats along the Porth Llwyd valley

The break in the dam and the cut through the peat

Cauldron of emergence below wall of Llyn Eigiau, and stranded peat rafts

The main channel of the cut through the peat, looking S.S.E.

Rock-steps swept and fractured by the flood at head of downfall

there is a variable but considerable thickness of recent peat. Where the concrete wall was built the peat bed, 4 to 6 feet thick, was stripped off, and the surface of the boulder clay, which had been soil when the peat plants started growing, and so had suffered further alteration during the long period during which it had been kept soaking underneath the peat, was cut into. Some of the wall was built upon this peat-altered soil, and to the south of the place of the washout the excavation done in preparation for the reception of the wall's foundations was not carried deeper than a foot or two into the fresh unweathered boulder-clay below

The rest level of Llyn Eigiau is 1219 feet above sea-level, and for months during the summer and autumn of 1925 the water was so drawn off to serve Dolgarrog that the whole length of the eastern wall was left high and dry. The fortnight beginning October 17 was a very wet period, and by November 2 the lake had filled up to 1241 feet, *i.e.* 2 feet above the lip of the spillway and within 3 feet of the top of the wall. The burst seems to have come as if by the rising of a spring, and the enlargement of the passage which it forced must have happened very rapidly; the water descended quite close to the inside of the wall and emerged in the midst of the almost flat saddle also within a yard or two of the wall on the outside. Within a day the level of the lake fell from 1241 to 1229 feet, and at least 110 million cubic feet of water must have passed through the hole, which was left steep-sided, rudely circular in plan, 30 feet wide and about 18 feet deep, the part of the concrete wall above ground-level being left standing as a bridge. The hole excavated has been referred to as the "cauldron of emergence"; its sides show 4 to 6 feet of peat resting upon yellow, weathered, and very sticky boulder-clay, which in a further 3 to 6 feet passes down to blue-grey unweathered boulder-clay with ice-scratched stones, and grooved and polished boulders of very variable size.

From the cauldron of emergence the waters seem to have boiled out and spread eastward across the flat-floored hollow of the saddle as a widening fan, and over the first hundred yards the flood did not score the surface or uproot the heather or the grass. It was clear lake-water, and its only load of solids must have been quarried as it came through the cauldron of emergence. The peat disturbed was evidently lifted in rafts, and quite a large proportion of the peat which covered the former surface of the cauldron is accounted for in 4 to 6 feet square irregular or pyramidal masses, left overturned each with its root-clay still adherent, rudely aligned where they stranded along the edges of the flood. Discontinuous trails of medium-sized stones, and sand or gravel, including little bits of concrete from the wall, can be traced among bracken and low bushes within this part of the track of the flood.

The Disruption of the Peat-Moor

A little way below the cart-track which is the district roadway to Cwm Eigiau, the slack in the moraine surface becomes appreciable, and in it, instead of widening further, the waters concentrated as a stream. Having concentrated in a channel—it may have been 6 feet deep—the waters lifted up the peat, which, tearing apart, either floated off in cakes and stranded near the edges of the flood, or, rising, let the water run underneath and dig out deep runnels in the boulder-clay below. Along certain of these runnels, as erosion

progressed further, the main stream concentrated to 10 to 20 feet deep trunk ravines, and into these the severed masses of the peat later subsided or dropped without overturning.

One awaits a complete explanation of the mechanism by which all round the heads of the branch gullies these tough rafts of fibrous peat, tens or scores of square yards in area, have foundered bodily and almost uniformly through a height of several feet. The peat is here a 5 to 7 feet bed of hill-peat, mainly composed of reed and heather, with a well-defined basal layer of birch and possibly oak scrub, well-rooted in the clay below. In general the peat bed is so well fastened to its surface soil that those peat cakes which have floated have carried some 6 to 10 inches of the boulder-clay with them. The length of this cut through the peat is about 250 yards, its width varies irregularly from 15 to about 35 yards, and fully one-third of all the peat disturbed remains within a few score yards of the position of its growth. The small stones and the clay matrix of the boulder-clay excavated below it went forward with the flood, but the larger stones were only trundled down slopes steeper than 1 in 12, and rejected along distributaries in a fan or delta where the flood spread itself on the floor of the main Afon Porth Llwyd valley. The largest boulders uncovered were not moved by the flood, and remain in the sides and floor even of the trunk ravine.

For a mile below the place where the flood joined the Porth Llwyd river, *i.e.* beyond the stepping-stones on the path from Pwll Ddu to the Trasbwll Farm, it did no work of erosion or deposition which is now appreciable. It spread widely, a few feet deep, over all the valley, but the slope (about 1 in 20) did not give the shallow waters velocity sufficient even to disturb the grass. Thence to the intake of the Eigiau leat (1050 feet) at Pont Pwll Ddu and downstream to the old sheep-fold between Fachell and Diffwys, though the banks are all boulder-clay, the course is a little steeper and the valley narrows to a shallow gorge. This is the head of some phase of post-glacial rejuvenation of the river course, and when the flood came down erosion became so active that in mid-course the bed of the channel was lowered by at least 10 feet, and many tens of thousands of tons of stones, including many 6-feet boulders, were dumped in *levées* by the distributaries of the torrent at the head of what was, and is now again, the Coed-ty or Low-level Dam, below 880 feet.

The behaviour of the flood at bends along this part of the river course is noteworthy. The momentum of the torrent at every point tended to carry it straight on. Compelled to bend, it threw out storm-beach *levées* of boulders a few feet or many inches in diameter, high along the sides of slack water. Swinging round, it undercut each opposing bank, and beside thus widening the amplitude of incipient meanders, it lowered its bed around each bend by ten or a dozen feet, and left lengths of pre-flood channel high and dry across the chords of the arcs. The length of this section of the river is a little more than half a mile, the fall is 150 feet, and no solid rock is anywhere exposed.

The Destruction of the Coed-ty Dam

The office of the Coed-ty or Low-level Dam is to collect the water gathered by the low-level leats, and to hold the spills from the high-level leats as they come from Eigiau and Cowlyd. During the last days of October 1925 water

had been coming down the Afon Porth Llwyd so fast that the low-level dam was full and spilling from the 26th. The flood from Eigiau therefore quickly overfilled it, and for a while it overflowed both by its spillway and to a depth of 6 inches (some say a foot or more) over the whole 1000-feet length of its parapet. The spillway was so placed some few yards along the incoming feeder leat from the south that, with the extra volume and velocity consequent upon the flood, its outrush could reach and scour away the toe of the earth dam of the reservoir. Thus pressures which had never been expected came upon the concrete core-wall of the earthen dam, which, opposite the foot of the spillway, shortly after 8 p.m. on the evening of 2 November 1925, gave way bodily, and 12 million cubic feet of water were released through the breach to complete the Dolgarrog flood disaster. Eigiau took a day or more to empty from 1241 feet to the new rest level of 1229 feet, but the 38-feet-deep Low-level or Coed-ty reservoir emptied through the breach, which widened to 120 feet, within the hour. The dam, as since re-built, has been provided with a new 58-feet-wide spillway which discharges directly along the course of the Porth Llwyd stream.

In the two-thirds of a mile next below the Coed-ty Dam, the Afon Porth Llwyd flows north-eastwards, turning slightly to the eastward as it descends. Its narrowing channel is incised in boulder-clay, but from the 800-feet level just above the site of the bridge Pont Newydd, solid rock appears continuously in the bed and low down along the right bank of the stream. Two hundred yards below the dam the pipe-line conduit crosses, supported on piers and secured with anchor-blocks of concrete, 10 to 15 feet above the bed of the stream. The parts of this which were sited directly in the course of the outrush were swept forward, anchor-blocks and all, and borne onwards down the ravine to Dolgarrog. Some of the 6-feet pipes went all the way, but long lengths, bulged, torn, and twisted, stranded in the near-by shallows. The part of the pipe-line above the crossing was buried in stones and gravel from the bursting dam, and has since been cleared and repaired for further service. Considerable erosion of boulder-clay took place by the undercutting of the north bank, and rock shelves on the south bank were scoured and generally cleared of boulders; but there is no evidence that the bed of the stream was deepened in the solid rock.

Rhaiadr Porth Llwyd and the Ravine

From the 800-feet level where the solid rock first outcrops, the slope of the stream-bed increases rapidly, and from the 700-feet contour to the top of the fan of accumulated boulders where was Porth Llwyd, it falls 600 feet in half a mile. The upper part of the declivity is the outcrop of a complex of intermediate to basic igneous rocks, whose chief characteristic from the present point of view is the sparseness of its jointing, and the enormous size of the blocks into which it breaks. Occasional boulders of this rock type are not infrequent in the drift of the uplands, but below Coed-ty along the bed of the Afon Porth Llwyd large ones become increasingly abundant as the lip of the rejuvenated downfall, *i.e.* the Rhaiadr, is approached. There, except where in sheltered enclaves on the south side *levées* of small and medium-sized boulders have been cast upon the bank, all the loose blocks have disappeared from the

stream course, and only the quite large boulders remain. Two hundred yards east of Ty-croes cottage on the north side of the stream at the 650-feet level, one of these has attracted a good deal of attention. Its dimensions are roughly 15 by 15 by 15 feet, and on the face which is now undermost dead grass and bilberry plants remain hanging head downwards attached to the surface as they grew. This block of rock was certainly moved and turned over by the flood. Hereabouts, too, we first find signs of corrasive violence sufficient to have opened up slabs of slaty volcanic ash along its cleavage. One such slab, with several square yards of blue unweathered surface uppermost, was trapped, and remains partly protruding between the mentioned inverted block with its "vegetable whiskers" and the knob of solid rock against which it came to rest. Other fresh-broken chunks were left among boulders and uprooted trees along the south edge of the flood, and there is one very fine slab perched prominently, along with a battered tree and a large boulder, on the top of the upstanding crag which parted the torrent at the top of the Rhaiadr.

In view of this demonstration of the flood's violence, close watch was kept for any evidence of plucking out of joint-blocks from solid rock. No certain evidence of such action was observed. But at the edge of the rock-step next above the lip of the downfall, the foot-joints slope outwards at from 10° to 15°, and these, with other joints, divide the rock into rude cubes measuring from 10 to 20 feet along the edge. The pre-flood stream had here worn out channels along the vertical joints, which left some of the blocks which form the rock-step with more than one free side, and during the flood foot-joints on the down-stream side also were scoured clean. The steeply inclined joints at the back of the blocks are now open, or half filled with boulders which have jammed, but even with these very favourable conditions the evidence that the gaping happened during the flood is not conclusive.

From the lip of the Rhaiadr at 620 feet, the Afon Porth Llwyd in pre-flood days cascaded partly over solid rock, elsewhere among large detached rock masses, some of which were glacial boulders and others unstable joint-blocks which had slipped away from their places on the cliff. Vegetation was there abundant, and in the stream-bed pot-holes were numerous, drilled both into solid rock and into boulders among which the waters fell. A search along the south bank would have discovered water-worn rocks and deserted pot-holes far above stream-level. The northern bank as far down as the sloping ledge above the waterfall, about 300 feet above sea-level, was of boulder-clay, and lateral shifting of the stream course had been long in progress towards the north. The average slope from the lip to the ledge is not less than one in two, and the flood swept out every loose block and boulder along its track. Trees were torn up by the roots, and all traces of soil and weathered rock, even from the joints, were cleaned out up to a well-defined mark, which is evidence that at peak height of flood the waters still kept within a course whose cross-section between the top of the downfall and the exit of the gorge nowhere exceeded 2000 square feet.

Pouring over the downfall with the waters came the boulders which the torrent had quarried from the upper part of the ravine. These, leaping from the lip, crashed heavily on the rocks below, and at intervals all down the face of the Rhaiadr ledges and corners have lost great pieces whose former positions

are marked by unweathered and generally triangular scars. The largest of many such scars noted measured 12 square feet. Above the 400-feet level the proportion of surface thus broken is small; but below, where towards the base of the basic intrusion the jointing is less massive, and sills of dolerite break across the beds of indurated slate whose outcrop forms the sloping ledge, with slackening of slope came increased opportunity for battering, and there few of the knobs of rock upstanding in the stream course have escaped. Even the smooth stream-bed has suffered considerably, and near the edges of rock steps which gave way under the hammering the fronts of several of the old pot-holes have been smashed away, and their backs left, looking more like armchairs than cauldrons.

The right bank of the Rhaiadr is solid rock: the left bank at the lip is also solid almost to the top, but within a few yards downstream on that north side, the visible thickness of the drift increases soon to more than 50 feet, and along most of the next 100 yards down to the waterfall at 300 feet above sea the cascading stream is undercutting an almost vertical face of boulder drift. This drift appears to occupy an ancient valley which bears away from the present stream-course towards the north-east. The outcrop of the black slates, which at the foot of the downfall underlie the igneous complex, crosses the present stream obliquely, and on the north bank forms a sloping shoulder and ledge of solid rock. At the lower level its rise reduces the thickness of the drift on the north bank, and it is reasonable to infer that before the present Porth Llwyd ravine was excavated the slate rib must have formed the north-west-facing bank of the old channel.

The moraine material which fills the pre-drift valley rests upon an unweathered pavement of glaciated rock, and during the flood the base of its undercut cliff shifted laterally some 20 to 40 feet northwards from the line of pot-holes which marks the course of the pre-flood stream. The moraine stuff exposed in the bank is a very stony kind of boulder-clay, deficient in clay matrix, and containing trails of very large rock masses which may well be joint-blocks tumbled from the near-by upstanding cliffs. The total volume of material excavated by the cataracting waters as they met this drift bank can hardly be less than 10,000 cubic yards, and the writer is in full agreement with his colleagues of the British Association Committee who have reported that this was the main source of supply of the stones under which the hamlet of Porth Llwyd lies buried. When the flood had passed the cliff stood vertical or overhanging, and not one loose stone was left upon the shelf of rock. Since then two years of weathering has rendered the position of several of the half-exposed big rock masses quite precarious, and two blocks, each larger than a 15-feet cube, and therefore weighing more than 200 tons, have fallen from the cliff and found lodgment on the steep rocks below. Smaller stones which must have fallen with them have been swept onward by the stream.

As one follows the line of the pre-flood stream, across the igneous rocks which form the Rhaiadr to the rock shelf which is the outcrop of the indurated slate, it becomes evident that the route of its crossing of the rock rib is controlled by the distribution of a number of parallel joints, between some pairs of which there has been movement and slight shattering of the rock. One pair of these is in alignment with the gorge of the Afon Porth Llwyd below the

waterfall at 300 feet, as far as its debouchment at the head of the boulder fan at 100 feet. That gorge with its three sets of waterfalls is deeply graven in rhyolitic rocks which are very compact and hard, and there is little doubt that its depth and straightness are due to the working back of the waterfall along a fissure with its shattered rock. Because the flood cut back the cliff of boulder drift, the stream above the waterfall at 300 feet had there to desert its former course, and for some few yards the waters now spread broadly over the shelf of indurated slate. Below, with the appearance of tongues of rhyolite among the slate, solid rocks stand up on both sides of the new stream-bed, and thence the cascading stream concentrates and pours from the north flank into the deep pre-flood gorge below.

Below the rock step, as at the Rhaiadr, the gorge of the Porth Llwyd was cleared of every particle that was loose. Boulder drift is not present, and below the level of the highest flood, which shows as a well-marked line of hanging tree-roots, only groups of medium to large-sized boulders standing on ledges in front of successive rock-pools obscure complete exposure of the solid rock. In views up-stream, these scattered boulders are difficult to see, and the general effect is a V-shaped rock-notch with a straight and narrow stream-course cut deeper in the angle of the V. At the 200-feet level steel bars protruding from a patch of concrete on the southern bank represent all that remains of the minor dam which was built 10 feet high and 6 to 4 feet thick to divert waters from one of the rock pools to the pipe which, before the flood, supplied the houses of Dolgarrog.

Within this swept and scoured gorge the actual surface of the solid rock deserves attention. Close down by the water the surfaces are unweathered, water-worn and polished, and have shapes characteristic of slow sculpture by cascading waters. Pot-holes in various stages of development and desertion are present at intervals along and above the stream-bed, and there is nothing to show that continued corrasion by the falling waters has been either interrupted or accelerated. Before the flood the stream-course was probably to some extent obstructed by blocks fallen from the sides, but though all these were cleared out there is nothing which suggests that the bed of the stream was deepened or otherwise appreciably affected by the flood. Up above the stream-course, though the solid rocks are quite unmoved, their surface shows no sign of water smoothing, but is rough as the cleared face of a man-wrought quarry, and has been formed by the removal of separated fragments along the rock's own joints. Cracks are numerous, and often close together, but there is little evidence of bruising, and no great new surfaces of fracture like those at the foot of the Rhaiadr.

Notwithstanding this difference, there is little doubt that the hackled surface of the rhyolite was produced by the hammering of falling boulders, as they were rushed downwards with the waters of the flood. The rhyolite is a hard, compact, closely jointed, but rather brittle rock, and when the blows struck were violent enough to disrupt its surface, the joint-blocks may well have shattered and broken away at the minor joint which lay next behind that surface. The height above the stream-bed at which this drastic kind of hackling begins varies with the depth and inversely with the width of the stream-course. In narrows close to waterfalls the smooth surface may extend upwards

some 20 feet, but all the rest of the 50 feet of steep and rather evenly sloping surface, up to the line of the tree-roots which edge the rock ravine, has been hammered and battered by the flood.

Towards the explanation of the apparent immunity of the old water-worn rock surface in the narrows from damage by battery during the flood, three suggestions may be offered. These are not mutually exclusive, and we have no means of knowing the extent to which each of them may apply. Firstly, it may be that during the early stages the flood so loaded itself with boulders from the drift banks, that where, in the narrows, its flow was of necessity constrained, it could not carry all of them and the gorge was temporarily aggraded. At height of flood the cataract was demolishing the drift bank below the Rhaiadr, and on the slightly less steep slope (1 in 4) of the ravine the big stones bumping against the sides were cushioned from contact with the crowded stream-course by the stones in temporary lodgment there. As the flow of water diminished the supply of boulders would diminish even more rapidly, and thus towards the end the flood had energy and opportunity to move and clear out all the loose material that lay or had been deposited along its course. Secondly, the wilderness of flood-borne stones which now buries the site of Porth Llwyd includes many blocks which are bigger and broader than the bottom of the gorge. These monsters could never have entered, much less travelled along, the narrows of the gorge; and it may be that only they were heavy enough to strike blows of sufficient violence to shatter the joint-blocks in the solid surface of the massive rocks along the sides of the ravine. Thirdly, the rocks in the bottom of the gorge are quite unweathered. The rhyolite which forms the hackled flanks of the ravine has, by longer exposure, changed colour from the original blue-grey to buff or pink, and specks of pyrites have oxidized to yellow ochre or to brown or blackish rust, which towards the top of the slope is widely distributed and fills the otherwise open joints. It may be that this slight degree of weathering has weakened and impaired the cohesion of the rock, which therefore, when hammered by the falling boulders, may have been strained and ruptured by stresses which were insufficient to break the unweathered rock.

At the foot of the gorge, a little above the 100-feet contour, the outcrop of rhyolite ends against silicified slate, inter-stratified with groups of thin and cherty ash-bands. Here the ravine widens a little and the incised stream-course loses its individuality. The height of the slate-rock walls decreases from 50 to 20 and even to 15 feet, and at high flood-level on the north side the waters overtopped the rock and undercut the covering of 6 to 10 feet of boulder-clay in which the trees were rooted. The cleavage of the slate-rock slopes steeply towards the south-east, and over a distance of about 50 yards along this northern bank it is clear that the flood waters worked in along joints which follow the slaty cleavage, and tore away some few hundreds of cubic yards of solid rock. Excepting the breaking of the hackled surface of rhyolite, this is the only place along the whole course of the Afon Porth Llwyd where one finds evidence of substantial breakage and removal of rock *in situ*. That the slate-rock quarried was sound and quite unweathered is proved by the fresh condition of its scratched and polished glaciated surface as it passes under the boulder-clay on the ledge which the flood has bared.

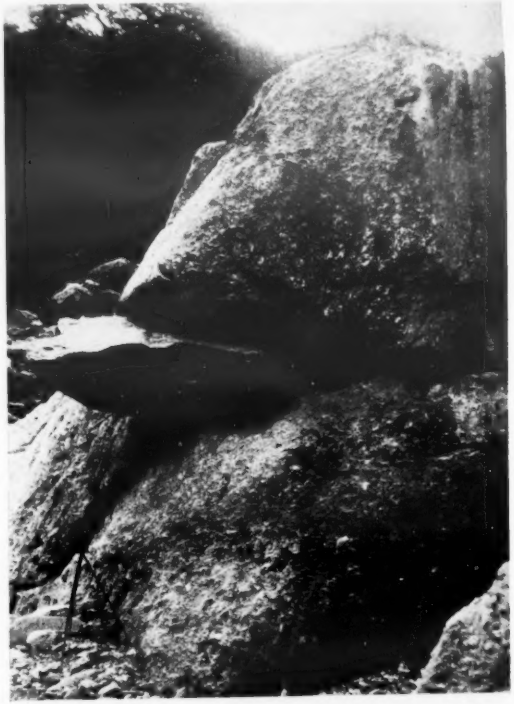
The Cone of Rejection

From the breach in the Coed-ty Dam to the foot of the gorge 100 feet above sea-level at Dolgarrog, except where a minor enclave in the side of the ravine has provided lodgment for a storm-beach *levée* of boulders, the whole story of the flood work is of dislodgment of material and the widening of the river course. From the foot of the gorge to the river's confluence with the Conway, following the obliteration of the hamlet of Porth Llwyd, there has been aggradation and the building of a fan of rejected débris on a quite tremendous scale. Visitors to Dolgarrog, and even the most casual of passers-by, cannot miss the wilderness of boulders which buries the site of the former hamlet from 40 to 10 feet deep, and spreads a thinning wedge of ill-sorted gravel and sand from 10 to 1 foot thick over a 60° sector of a circle, centred at the mouth of the gorge, whose radius is something over a quarter of a mile. Much sand and silt spread far beyond this, over all the low ground area in and about the buildings of the Aluminium Works, and on till the flood joined the tidal waters of the Conway. This cone of aggradation is highest directly in front of the opening of the Porth Llwyd gorge.

The breach of the Coed-ty Dam took place after 8 o'clock on a dark and wet November night, and details of the flood's progress have not been recorded. The 1919 edition of the 6-inch Ordnance Map shows the position of the church and half a score other buildings within the area desolated by the flood. The site of the church lies under some 30 to 40 feet of boulders, and even along the old main road, where the width of the cone exceeds 300 yards, the boulder-gravel deposited is from 6 to 10 feet deep. The ravine through which the main watercourse of the Afon Porth Llwyd formerly flowed, by the Porth Llwyd hamlet and on south-eastwards past the Aluminium Works, is almost completely filled with boulders: and the post-flood stream-course, diverted at the apex of the fan, now follows the north-east margin and crosses the road 200 yards north of the Aluminium Works. In the rehabilitation of the works, over 100,000 tons of gravel and boulders have had to be cleared from among the buildings and carted from the site.

In walking over the boulder fan, one recognizes that, in common with other torrential deposits, it shows rude grading, the largest blocks having remained near the apex of the slope. In detail, progressive reduction of the size of boulders takes place along a multitude of generally divergent but sometimes interlacing distributary streams, and is by no means regular or continuous along any one straight line across the fan. At the head of the fan the individual blocks are enormous. The largest visible measures 24 by 21 by at least 15 feet, *i.e.* more than 7000 cubic feet, and must therefore weigh over 500 tons. Three others are not appreciably smaller. One of these, which presents its flank along the south side of the present stream-course near the exit of the gorge, shows that side as an undamaged water-worn surface complete with potholes, and must have been turned over through one right angle at least. It has a shape proper to a glaciated boulder, but for ages it must have suffered corrasion as it lay in the bed of the stream. On one of its corners there is a newly broken scar 20 square feet in area, produced either by collision when the stone was tumbled down the ravine, or by blows struck as passing blocks went leap-frogging past it in the rush of their descent. The condition of this

The lower part of the gorge which escaped hammering by boulders



Large overturned boulder gripping smaller boulder against solid rock

The bank of boulder-clay from which the largest boulders in the Dolgarrog fan came: rock wall of pre-glacial gorge on left

The lip of the downfall, on skyline, and the Dolgarrog boulder fan

block is characteristic of hundreds of others, both large and small, which are available for inspection on the surface of the fan.

Half a dozen 500 to 400 ton blocks lie just below the 100-feet contour at the opening out below the gorge, and are neighboured on the downstream side by a dozen, perhaps a score, of blocks each weighing something between 300 and 100 tons. Thereafter, among continuously increasing numbers of a diminishing succession of smaller stones, there may be a hundred each weighing at least a score of tons. One does not dare to estimate the numbers of the hundreds and thousands of boulders between that and the ton or half-ton size. The condition of the surfaces of each of them shows that they have come directly or indirectly from the boulder-clay; but many, and especially the larger ones, bear evidence that they have had one side exposed to the weather, and some have adherent roots of trees, grass, or minor plants, tucked away in pockets, sufficient to prove that they were swept by the flood from a position on the floor of the old valley. A very few of them have been sufficiently hammered to have lost a corner, and still fewer is the number of those which have parted along a joint during the progress of their journey.

Since all the biggest blocks remain near the apex of the fan, it is reasonable to infer that these were only moved when the water-flow attained its maximum velocity. We have no direct measure of that velocity, but we have record that, following upon the breaking of the Coed-ty Dam, some 12 million cubic feet of water were released within the hour into a stream which was already carrying the flood discharge from the burst Llyn Eigiau, which was in course of emptying 120 million cubic feet of water during a day, as well as the run-off from the mountains after a fortnight of heavy rain ; and all this water was passing through a cross-section which from about 3000 square feet just above the Rhaiadr diminished to as little as 1200 square feet at the foot of the rocky gorge; and we can, therefore, suspect a maximum rate of stream-flow through those narrows in the neighbourhood of 10 miles per hour. This, on the 1 in 2 slope below the Rhaiadr, was more than sufficient to ensure the sweeping out of every 500-ton or smaller block which happened to be loose, and their transport to the foot of the slope of the gorge at 1 in 4. Below the foot of the gorge the sides of the flood were unconfined; and on this slope, which slackens progressively, at once to 1 in 6, and at the old main road to 1 in 12 or less, the load of large boulders fell out and was accumulated. With diminishing flow of water, the stream seems not to have been so well supplied with débris, but even as the waters fell they must have continued to bring smaller, though still comparatively large-sized, stones which filled the interspaces between the largest boulders. During these late stages of the flood the big blocks acted as immovable breakwaters, over and among which distributaries cascaded as minor waterfalls, scoring ravines or throwing out lateral *levées* of smaller stones, as in erratic courses they wandered to the apron of the fan.

In examining the constitution of the fan, a search for freshly broken rock pieces yields only slabs of black slate such as outcrops at the foot of the gorge, and with them a very few fragments of pink or buff rhyolite, probably from the bruised edges of the lower gorge. The big blocks are all second-hand glacial boulders, mostly of the kind of basic rock whose outcrop forms the

cliff of Coed Dolgarrog and the Rhaiadr of the Afon Porth Llwyd. With these are some well-rounded large lumps of compact dolerite, and a few slabs of fragmental volcanic rocks and ashy slates. Some of these bear scars of recent fracture, but fragments smashed from the boulders seem all to have gone to powder, and are impossible to find. Among these re-sorted glacial boulders, riven tree-trunks are not infrequent, and with these also are pieces of the 6-feet pipe-line which the flood brought from just below the Coed-ty Dam. Several of these were found as 10 to 30 feet sections, battered and twisted and partly collapsed. Several masses of concrete from the piers and anchor-blocks which supported the pipe-line also survived the journey, and one of these blocks, 10 by 6 by 4 feet, left close to the main road, has bent bars of its steel reinforcement protruding from its side. A block of the special kind of concrete used in the construction of the little dam which diverted water from the pool in the gorge at 200 feet above sea level was also recognized close to the bridge by which the new main road crosses the post-flood stream. Broken relics of the Porth Llwyd village were swept forward when its site was buried, and the church roof had to be dismantled where it stranded in what had been the main Trefriw–Conway road close down by the Dolgarrog Works.

Conclusions

The most striking of the modifications of natural topography produced by the Porth Llwyd flood have been stated very tersely in the Report of the British Association Committee, and, as the present authors agree with all the findings, there is no need here to recapitulate the local detail. The flood work between Llyn Eigiau and the Coed-ty Dam was done by the flow of 120 million cubic feet of water in addition to the normal flood waters of the river. The maximum rate of flow may have risen to 20 million cubic feet per hour through a channel never more than 5000 square feet in sectional area. On slopes less than 1 in 20 it accomplished no appreciable erosion. Where it spread over moorland on slopes steeper than 1 in 15, great rafts of peat were lifted and new channels cut among the stones and the boulder-clay beneath. Constrained by banks to an incised channel on a slope averaging 1 in 15, it entrenched its bed 10 or 12 feet deeper into boulder-clay, and trundled down to the flat of Coed-ty some thousands of tons of medium to large-sized boulders (up to 5 tons) which previously formed the floor of the stream course where they had been left by normal floods.

Below the Coed-ty Dam, the flow of water was for a time further reinforced by the emptying of its 12 million cubic feet within the hour, and at peak of flood the rate of flow may have increased to 20, perhaps 30, millions of cubic feet per hour. Where, for the first half-mile below Coed-ty, the slope is less than 1 in 10, the flood enlarged its cross-section to a little over 5000 square feet, and cleared out the pipe conduit, a bridge, great trees, with soil and weathered rock, and large quantities of fresh boulder-clay, leaving a very few 10-ton and larger blocks on the swept pavement of solid rock. As the slope steepened to 1 in 8 and 1 in 6 at the rock steps above the Rhaiadr, the only detached blocks which survive within the track of the deluge (whose sectional area is there reduced to about 3000 square feet) are larger than 10-feet cubes. On a rock step just above the Rhaiadr at least one 200-ton boulder was

inverted, but there is no evidence whatever of effective corrasion of any solid rock.

Spectacular alterations of topography wrought by the flood become evident at and below the Rhaiadr Porth Llwyd, where the present stream cascades down 200 feet of crags on a slope of 1 in 2, to a sloping ledge or shoulder, over which it enters the ravine with waterfalls, and completes a total fall of 500 feet at an average gradient of 1 in 4. From this steep slope, within the track of the cataracting waters, every projecting block, not firmly embedded or attached as rock *in situ*, was rooted out and swept away. What before the flood was a wooded ravine, well occupied with trees and fallen boulders, now presents a complete if almost inaccessible clean-scoured exposure of solid rock. Where the waters at the foot of the first precipitous descent fell against the bank of boulder-drift which marks the crossing of a slightly divergent pre-glacial channel, they undercut and removed some tens of thousands of tons of moraine, containing monster boulders, leaving a vertical or overhanging cliff upstanding to a height of 50 feet. The stream-course at its foot for a distance of about 100 yards was shifted laterally on the average about 30 feet. The velocity of the waters as they fell evidently accelerated, and the cross-sectional area occupied by the flood became progressively smaller from about 2500 square feet at the top of the Rhaiadr to 1200 square feet as it rushed from the foot of the ravine.

All the way below the Rhaiadr falling boulders scarred or smashed away outstanding ledges and corners of solid rock. The proportion of bare rock surface thus battered increases progressively down the steep descent, but only below the sloping shoulder where both flanks of the flood were contained by solid rock, does the proportion of surface thus bruised or shattered exceed 25 or 30 per cent. Along the lower part of the ravine, the whole of the rock surface exposed within 20 feet of high-water mark has been corraded and pounded away; but steep-sided narrows in the bottom of the incised waterfall gorge retain their pre-flood water-worn surfaces in an entirely undamaged condition. The total quantity of solid rock corraded does not exceed a very few hundreds of cubic yards.

The change of slope from 1 in 4 within the ravine, to 1 in 6 below the exit of the gorge at Porth Llwyd, so checked the torrent's rush that it carried the largest boulders very little farther; and on the slackening slope directly before it a typical cone of rejection was established. By the operation of distributaries this fan of boulders was completed symmetrically; and by aggradation over a 60° sector of a circle of a quarter of a mile in radius, all the existing surface features were either obliterated or concealed. Half a dozen individual transported rock masses at the apex of the fan weigh each more than 500 tons. The site of Porth Llwyd village is buried 20 to 40 feet deep under piled boulders, somewhat, though not very much, smaller. Two hundred yards from the apex the slope slackens further to 1 in 12 or less, and the ruling grade of the deposit is small boulders mingled with pebbles. There, along 300 yards of the main road, the new ground-level is 6 to 10 feet above the old road surface. Almost all the boulders in the fan have forms hardly modified from those in the local glacial deposits. Some are deeply weathered, and a few have a characteristic stream-worn side. Smashed corners, fractured edges, and

scars produced by collisions during transport, are more noticeable on the larger than on the smaller blocks. The proportion of unweathered slabs and angular rock chips made by the splitting or shattering of solid rock is small. No detailed plotting of the pre-flood form of the ground is available, and it has, therefore, not been possible accurately to determine the total quantity of material deposited in the building of the new topography. On meagre evidence it has been estimated that the volume of flood-borne débris left within a quarter of a mile of the Works of Dolgarrog is not less than 4,000,000 cubic feet.

DISCUSSION

Before the paper the PRESIDENT (Col. Sir CHARLES CLOSE) said: Professor Fearnsides, who is going to talk to us this afternoon, is Professor of Geology at Sheffield University. He has made a topographical study of the effect of the bursting of the dam at Dolgarrog, and we have an opportunity of seeing what effect a definite quantity of water, suddenly released, will have on the topography.

Professor Fearnsides then read the paper printed above, and a discussion followed.

Professor E. H. L. SCHWARZ: The paper brings out several important points in ordinary geology. When estimating the erosion of a stream, as has been done, by putting gun-metal pins in the river-bed and going from year to year to inspect them, it has been found that little has been worn away, hence statements have been made that the erosion of a stream is exceedingly slow. Those who live in countries where violent storms occur, as in South Africa, know that the main erosion is not carried on by the ordinary flow of the river but is accomplished during great storms. I think this example of a big rush of water, the enormous amount of material it has carried and the battering it has done on the river-bed is valuable as showing what a river can do in its real fury and is of very great interest from a general point of view.

A river, if flowing at so many miles an hour, can shift sand or gravel of a certain size, and therefore we ought, on account of the size of the boulders moved in the great rush of water that has been described, to be able to estimate the velocity of the water. I am not sure whether Professor Fearnsides has given figures, but I should imagine that if he would calculate out the velocity of the water capable of moving such enormous stones it would be most helpful. I strongly suspect that such calculations will show that the velocity attained was not sufficient to move such large blocks. If water cannot move them, what has done so? We are often up against the same difficulty in regard to rivers of the Karroo, which are like those of the Falkland Islands, in which there are great masses of big boulders that have been moved in quantities, forming stone rivers. Again, in great volcanic eruptions we find not water but volcanic gases mixed with ash have carried stones as big as a small house in some cases; in the island of Martinique, for example. I am trying to find some means by which large rocks, such as we have seen on the screen, can be carried. Was it pure water that moved them, or was it not rather a sort of mud-rush: that the water was full of mud and clay, and that the specific gravity of the fluid was not 1, but something approaching 2 or 2½, and under those circumstances it could float big stones? I should like Professor Fearnsides to say whether he thinks there is any reason in that supposition. Certainly it is a most extraordinary occurrence, and I am glad to have had the opportunity of seeing the slides.

Mr. J. H. REYNOLDS: I was in Cwm Eigiau in the very stormy September of 1920. The wind was blowing directly down the valley with great force, and I

remember seeing the water slopping over the dam rather violently, so that the lake must have been very full at that time, which was during a spell of wet weather.

The position of Llyn Eigiau has always struck me as curious. It is unlike the two lakes in the valleys to the south, Llyn Cwlyd and that beautiful lake Llyn Crafnant. They lie along their valleys in the normal way; but if you look at old maps of Llyn Eigiau before the dam was built, you will find that the main stream entered and left the lake within about 150 yards. The lake stretched away for about a mile in exactly the opposite direction to that from which the main stream entered it. I do not know whether there is any evidence that the stream ever left the far (north-east) end of the lake. I imagine the rainfall in the upper part of Cwm Eigiau is pretty heavy, as it is under the lee of Carnedd Llewelyn, the second highest mountain in Wales.

Though I know it has nothing to do with the paper, I should like to know why the Ordnance Survey writes Dolgarrog and not Dolgarog; still less can I understand the spellings Cawlyd, Cowlyd in place of Cwlyd. Moreover, Pen yr Helgi in the new 1-inch map must surely be a draughtsman's error for Pen Helig.

In connection with the paper it would have been interesting if Mr. Hay, who read a paper here a fortnight ago, could have been present to tell us something with regard to the bursting of the dam at Keppelcove Tarn under Helvellyn. I believe his house was in the line of fire, and he could have said something interesting about it.

Mr. A. R. HINKS: I would like to ask Professor Fearnsides whether he has any mathematical colleagues interested in the question as to the carrying of the boulders; whether the velocity of the water required to lift a boulder has been investigated hydrodynamically. Professor Fearnsides is now at Sheffield, and he used to be at Cambridge. I am sure either Sheffield or Cambridge could produce the mathematical force necessary to investigate this question. It is certainly important to know whether water alone was responsible for moving the large stones, or whether it requires a specific gravity of 2, as Professor Schwarz thinks. I should suppose a good deal of the efficiency of specific gravity would be lost by the loss of velocity.

I do not know whether geographers have had a mathematical investigation of these matters, and I do not know that the point has been made in the discussion, but I take it that there is very great importance in such an investigation as a key to discussing what has happened in glacial times. There must be many geological structures due to bursts of ponded-up water at the end of the Ice Age and so on, upon which these particular investigations of Professor Fearnsides must throw a good deal of light. I suspect he had that in mind at the time but did not mention it.

Professor W. G. FEARNSIDES: Several of the questions raised in the discussion have been dealt with in the paper, though I have not had time to mention them this afternoon. I have done my best to obtain information on the question of stream velocities, but have secured few figures which I can trust. The cross-section of the narrowest part of the flood-course is a little more than 1250 square feet. I believe there is evidence to show that within one hour 30,000,000 cubic feet of water went through. If one takes that as a mean maximum velocity during one whole hour, it comes to 4·5 miles per hour, which is very disappointing, and I do not accept it. The cross-section of the flood-course where the slope is 1 : 20 is about 5000 square feet. Where the declivity increases to 1 : 2, the cross-section is diminished to 2500 square feet. Evidently, as the water accelerated, its cross-section was drawn down. The narrowest cross-section is just at the apex of the boulder-fan, and it is there that we have met with the 1250 square

feet cross-section. Immediately in front of that, where the slope changes from 1 : 4 to 1 : 6, the 500-ton blocks were deposited. The flood could not carry them on. It did at 1 : 4, but not even at peak of flood could it carry the big fellows down a slope of 1 : 6. Similarly, when we get the slope of the apron of the fan slackening to 1 : 12, the maximum size of boulders is about 3 feet, and from that we can carry on and get a number of other figures. Since on the fan the water was distributing itself, sometimes going one way and sometimes another, we have no criterion to show how much water went in any particular direction.

The main flood came down after 8 o'clock on a dark and wet November night, and it was all over when the unfortunate people were able to overlook the débris next morning. There is a tragic story connected with this happening, which it is not our business to record, but the tragedy of the disaster has not made the investigation into the mode of its progress any the more easy.

I think Professor Schwarz's suggestion that during their downward journey the big stones were buoyed up in a rather dense mixture of smaller stones and water, is useful and very reasonable. I am not sure how much of such extra buoyancy is required. When one does a calculation one finds that during the whole flood the quantity of solid material moved by the waters did not exceed 5 per cent. of their volume, or about 7 per cent. of their weight, which does not seem an undue proportion to have been disturbed and transported by the eddying waters on such a slope. My mathematical friends have told me that the carrying power of water does not depend directly upon its horizontal velocity: that nearly all its effective work is done by resolution where its forward flow is diverted and it rolls in turbulent whirls. They suggest the analogy of rolling marbles, or of pennies being bowled along on their edges by water jets which strike blows on their tops. Most of the measurements on the carrying power of water have been made by experiments with sand-grains falling through uprising counter-currents, and we know hardly anything about the mechanism of the trundling action of flowing water. The people who have the best of this information are the mining folk, whose business it is to separate mixed materials of varying specific gravity: as, for instance, the makers of the Rheolaveur Coal-Washer, which trundles mixed coal and shale down a sloping water channel, and by trapping the pieces which fall to the bottom at successive stages effects an almost complete grading of the coal, and the separation of the unwanted heavier materials. These people have made very careful investigations of the relations of velocity to carrying power, and although coal is a material not so heavy as most of the rocks which river floods transport, they have accumulated much very useful information.

With regard to the location of Llyn Eigiau, I agree with Mr. Reynolds that it is distinctly anomalous. The upper part of Cwm Eigiau seems to me to have nearly all the features of a normal glacial corrie. When we come down to the level of Llyn Eigiau we look for a second rock step, but do not find it. We find instead on the north side of the valley a great cliff, Craig Eigiau, forming a shoulder almost transverse to the general direction of the valley, and close under it, as it were in the armpit under that shoulder, is Llyn Eigiau. The steepness of the crags behind, *i.e.* west of the lake, suggests that all the way down to the water-level they owe their form to glacial plucking of well-jointed rocks. The material which forms the bank in front of the lake, and upon which was built the concrete wall, is not however material such as is generally produced by plucking. It has all the characteristics of ground moraine which has been long overridden by moving ice. Every stone in it has been scratched, and its form is rather that of a drumlin than of normal snow-slope detritus or lateral moraine.

Llyn Eigiau is therefore properly described as a lake impounded by irregular accumulation of ground moraine on the upland plateau, and its position under the lee of the great shoulder of Craig Eigiau is quite anomalous. The whole story, in fact, of the glaciation of this corner of Carnarvonshire is anomalous. Ice from the Irish Sea came inshore from the north, and left the gravels with Pleistocene seashells 1600 feet high on Moel Tryfæn and elsewhere on these hills. Local glaciers from the Conway and from Northern Snowdonia generally were therefore unable to find egress to the northwards so long as the Irish Sea basin remained full of ice. The height of the upland plateau in the neighbourhood of Eigiau is only 1200 feet, and we do not yet know to what extent the disposition of its drift covering was determined by the movements of the local glaciers, and to what extent controlled by the invading Irish Sea ice.

There is one other point with regard to glaciation. I have stressed the fact that below the Rhaiadr Porth Llwyd the waters fell against a bank of boulder-clay, and I showed a picture of the rock-step halfway down. I gave reasons for the opinion that that rock-step is the eastern bank of a pre-glacial valley, and that there a buried stream-course diverges to the northward from the present course of the Porth Llwyd. The whole of this drift-filled valley is a notch cut into the steep, rejuvenated lower Conway valley. Extreme glacialists would have us believe that the lower Conway valley is a glacial trough incised deeply into the upland plateau because of the relatively great activity of the Conway valley glacier. The preservation of a steep pre-glacial stream-course on the side of a deeply incised main valley, where all the hill spurs have been truncated, is rather difficult to explain on the hypothesis of glacial over-deepening. We require a revised reading of the glaciation of the whole Conway valley region, and until the whole area has been fully investigated I think it unwise to advance an alternative explanation.

The PRESIDENT: Before thanking Professor Fearnsides I should like to deal with the remark made by Mr. Reynolds with regard to Welsh names. All Welsh names on Ordnance maps have been submitted to experts. They do not always agree with each other, and when they do not agree somebody has to choose the version required for the map. But if any one thinks there is a name wrongly spelt on an Ordnance map it would be well if he would write to the Director-General of the Ordnance Survey, who will have the matter inquired into again. Obviously it is not for any mere Englishman to say offhand whether a couple of Welsh names are rightly spelled or not.

Professor Fearnsides has given a very admirable account of circumstances which we hope will not often happen, but we recognize from the facts he has put before us that we have a new study which deserves our attention and which we shall be able to consider further when we see the paper in the *Journal*. I was interested in the remarks with regard to the force required to move boulders, and have no doubt there is something in the contentions put forward. I take it that the mere force of gravitation has much to do with it, because obviously the slope affected the movement of the boulders. On a very gentle slope you would not find the boulders coming down.

In your name I thank Professor Fearnsides for his interesting lecture.

THE WORK OF THE JUBALAND BOUNDARY COMMISSION: *A paper read at the Meeting of the Society on 7 May 1928, by Capt. E. H. M. Clifford, M.C., R.E., Assistant Commissioner, in the absence of the author, the Senior British Commissioner*

LIEUT.-COL. L. N. KING, R.E.

THE Pact of London of 1915 heralded Italy into the Great War as our ally, and it was the natural outcome of this alliance that the fruits of victory should be shared. In due course it was decided that, in lieu of acquiring an actual portion of conquered territory, Italy should receive the Province of Jubaland, to be shorn from the Colony and Protectorate of Kenya. The cession took place on 29 June 1925, and was signalized by the change of the national flags at Kismayu on that day. It was my lot to be present at this ceremony, and I do not think that our friends and late allies could grudge the feeling of regret that fell upon the small band of Britishers who supported our High Commissioner, the late Mr. J. O. W. Hope, C.M.G., on the occasion.

For exactly a year from the date of cession Jubaland, renamed Oltre-Giuba, existed and flourished as a separate Italian colony under the High Commissionership of H.E. Corrado Zoli. Road construction and building advanced apace, and many great improvements were worked in Kismayu. On 29 June 1926 the colony was absorbed by Italian Somaliland and forthwith completely lost its entity in a number of pre-existent provinces. Signor Zoli, having handed over his responsibilities to the Governor, H.E. de Vecchi, returned to Italy to take up a senior post in the Colonial Office.

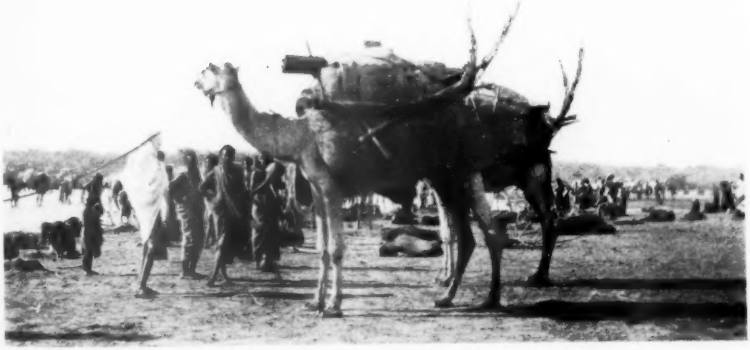
The authority for the cession of Jubaland was the Anglo-Italian Treaty of 15 July 1924, ratified by Parliament on 27 March 1925. Under Article 12 of this treaty there was authorized the appointment of an Anglo-Italian Commission, later known as the Jubaland Commission, with power to investigate and decide certain matters specifically stated in the treaty, and also to decide generally on the manner in which the treaty should be put into force. The Jubaland Boundary Commission, on the other hand, did not receive its charter directly from the treaty, but was naturally a servant of the Jubaland Commission, owing allegiance to it in all matters regarding delimitation, survey, and demarcation of the boundary. It might well be imagined that this overshadowing of the junior commission by another field commission would have led to confusion in many directions, but fortunately during the period of field activities the Senior Commissioners of both nationalities held their titles with respect to both commissions, and on occasions when a decision had been made, it was a nice point as to whether the responsibility was due to the senior or to the junior commission.

Early in 1925 the leadership of the British Section of the Commission was offered to me, and my acceptance was not delayed many hours. Then there followed a month or so before the appointment was finally approved by higher authority, and I devoted a portion of this time to a very careful perusal of the treaty description of the boundary, which ran as follows:

> "From the confluence of the rivers Ganale and Daua, along the course of the Daua upstream to the southern point of the small southerly bend of the latter river in the vicinity of Malka Re ; thence in a south-westerly direction

Ferry on the Juba river at Dolo

The Webi Daua, looking east from Malka Rie boundary pillar



Somali camels at Yaqali

The Wajer-El Wak road

A road crossing the boundary

A well at El Sadi, Wajer Dima

in a straight line to the centre of the pool of Dumasa; thence in a south-westerly direction in a straight line towards Eilla Kalla (which remains in British territory) to such meridian east of Greenwich as shall leave in Italian territory the well of El Beru; thence along the same meridian southwards until it reaches the boundary between the provinces of Jubaland and Tanaland; thence along that provincial boundary to a point due north of the point on the coast due west of the southernmost of the four islets in the immediate vicinity of Ras Kiambone (Dick's Head); thence due southwards to such point on the coast. Ras Kiambone (Dick's Head) and the four islets above mentioned shall fall within the territory to be transferred to Italy.

"In the event, however, of it being found by the Commission referred to in Article 12 that the well of El Beru does not contain water either sufficient or suitable for the maintenance at that point of an Italian frontier post, then the line, as between El Beru and Eilla Kalla, shall be so drawn by the Commission as to include in Italian territory the neighbouring well of El Shama."

There were several points in this description that promised to produce difficult but interesting problems on the ground, but there was one which appeared to me to need immediate amendment. The inland terminal of the old Jubaland–Tanaland boundary was a little shaky. Measurement on the 1/M treaty map showed the pivotal point of the international boundary in this region as occurring at 0° 50′ S. latitude. My proposal that this latitude should in fact be adopted was accepted without demur, and subsequently this corner point was very conveniently named "Zero Cinquanta."

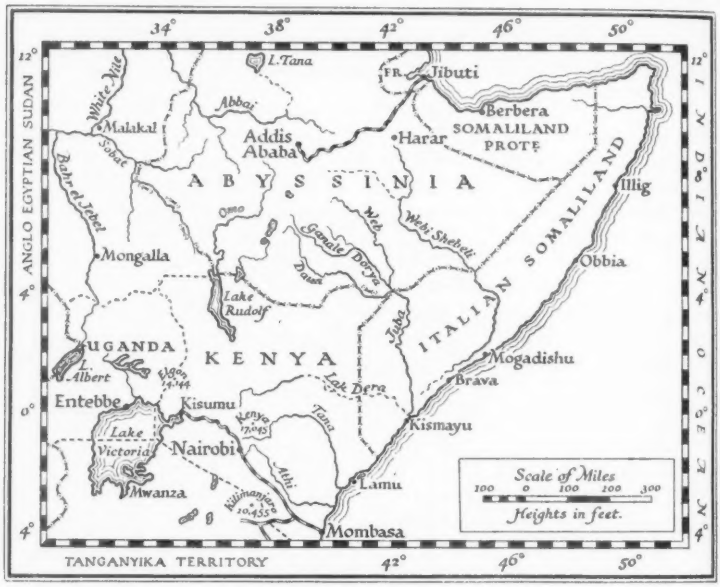
As my knowledge of Jubaland was very small, I requested that I might proceed to Kenya forthwith with one non-commissioned officer and reconnoitre. This request was accorded, and I sailed from England in March 1925 with Sergeant Foster, R.E. Captain E. H. M. Clifford, M.C., R.E., and another non-commissioned officer topographer were earmarked to follow me when required.

Arrived in Kenya, I found that Mr. J. O. W. Hope, C.M.G., the duly accredited High Commissioner for the cession of Jubaland, was on the point of proceeding to Kismayu, and I arranged to accompany him, as this appeared to be the surest way of establishing contact with the Italians. Unfortunately, I was somewhat in advance of useful events, as there then ensued two most unprofitable months of waiting. At last, on 29 June 1925, as already related, Jubaland ceased to fly the British Flag. I then appreciated the situation as follows: The Italian Mission was fast approaching. Work on the boundary would undoubtedly begin in the region of El Wak as soon as the Jubaland Mission had decided which well should determine the "long meridian." Wajer would be the British advanced base in the first instance. I then made my request that my reinforcements should be made available in Kenya as soon as possible. Unfortunately the Kenya Government was not able to abide by its contract regarding the provision of personnel for the Boundary Commission, as originally schemed, to the extent of a Political Officer, a Doctor, and a Topographer.

By good luck, however, I had on my staff as interpreter in Italian to the Senior Commission, Captain E. N. Erskine, M.C., son of St. Vincent Erskine, whose name will be remembered in connection with the exploratory work of the 'seventies. This officer, who had just severed his connection with the

Kenya Government, had obtained wide experience of administration in Jubaland and the N.F.D. whilst soldiering with the K.A.R. I engaged him forthwith as Political Officer to the Boundary Commission, pending confirmation from the Colonial Office, and a most "Admirable Crichton" he proved to be. The deficient topographer was made good from home. At an early period I tried, in conjunction with my Italian colleagues, to obtain the services of a doctor of the Oltre-Giuba Administration. When the news of failure arrived much time had passed, and as the transport question had become extremely acute, I very foolishly decided to save the extra lift involved.

As soon as the Senior Commission began to function an itinerary was



The Jubaland Boundary

The old Province of Jubaland comprised the area between the Juba and the new International Boundary, plus a triangle with vertex in the Lorian Swamp (about the L. in Lak Dera) and base the meridional section of the boundary

arranged to Wajer via the Juba River, Serenli, and El Wak. Captain Erskine hurried ahead to Serenli in order to assist Lieut.-Col. Costa over the purchase of camels, whilst Mr. Hope, Sergeant Foster, and I ascended the Juba to the same place in the *Buffin Bird*, a powerful little river steamer named after the mythical bird of Jubaland which is reputed to fly backwards, as it dislikes to have dust in its eyes! The Italian Mission followed us by land a month later and reported two amusing incidents on the way. The survey chronometer, which had been nursed with such infinite care ever since a tram conductor in Florence was requested to drive carefully because of his precious burden, was projected by an angry mule into the bush with such force that it parted company not only with the European who shared its degradation, but also with the

wooden case in which it was securely locked. On another occasion the intrepid Major Zammarano was requested by some villagers to destroy a lion which had worked sad havoc in the countryside. He spent a watchful night in a tree over a specially prepared bait, but to no purpose, for the lion preferred to stroll to the other side of the camp, where he deliberately killed and ate his fill of a grazing camel belonging to the Commission.

The Italian Section of the Boundary Commission was now completely assembled at Serenli and consisted of Lieut.-Col. Giovanni Dotto in command, assisted by two topographers, Captains Armando Marino and Cosimo Bertacchi, and a wireless operator, Sergeant-Major Angelo Branco. It will be noted that there was no Political Officer, no escort officer, and at this time no special transport officer.

As the British Section was now also in Africa, though not assembled, it is convenient here to detail its full composition: Senior Commissioner, myself, Lieut.-Col. L. N. King, O.B.E., R.E.; Assistant Commissioner, Captain E. H. M. Clifford, M.C., R.E.; Political Officer, Captain E. N. Erskine, M.C.; escort officer, Lieut. C. B. G. Watson, K.A.R.; wireless operator, Mr. A. Kane; topographers: Sergeant C. W. R. Foster, Corporal L. T. Higson, and Corporal J. Keleher, all of the Royal Engineers. In addition to his duties as Political Officer, Captain Erskine was responsible for all matters pertaining to transport, supply, water supply and discipline, other than military discipline.

Up to this date all arrangements had been made in anticipation of Lieut.-Col. Dotto's arrival, and it was fortunate that he was able to accept them in every detail. As soon as the transport was ready we bade adieu to our very true friend, Lieut.-Col. Costa, who had entertained us so kindly for many weeks, and the two Missions moved in echelon to Wajer, via El Wak, along one of the oldest slave routes in Africa.

Two days after my arrival in Wajer I left my Italian colleagues in the sympathetic charge of Captain Mahoney, who was administering the station and district, and made a flying visit to Nairobi by car, bringing back with me Captain Clifford and Mr. Kane, the two non-commissioned officers being left on the road to expedite the forwarding of stores. The question of transport between Nairobi and Wajer had caused Captain Clifford immense trouble. He was eventually compelled to make private motor contracts at ruinous prices, as the K.A.R. transport was more than fully occupied with the change of administration from military to civil. My return to Wajer was most opportune, as I had evidently been racing the "short" rains which now, November 1925, broke with exceptional violence and rendered the earth road behind me quite impassable for many weeks.

Mr. Hope, whose work with the Senior Commission was concluded for the time being, was just able to escape with the returning car, and this was the last sight I ever had of my very dear friend.

Previous to Mr. Hope's departure the Jubaland Commission had decided that the well of El Shama, and not that of El Beru, should define the boundary in this region.

From personal observation of the type of country already traversed from Serenli, combined with comparative information supplied by Captain Erskine regarding the various portions of the frontier, it was apparent that the topo-

graphical conditions were as follows: Hills from Malka Rie to El Wak and slightly farther south; then an immense plain extending to the sea; a ridge or two of coral outcrop near the coast. The vegetation, dense camel thorn about 12 feet high from Malka Rie to Zero Cinquanta; thence rather more open gladey country to Jibichilaowa; then a dense tropical forest, giving place again to camel thorn near the coast. The conditions of water supply were likely to prove extremely precarious, as there was no permanent water adjacent to the boundary other than the wells of Wajer Bor and the El Wak group; elsewhere surface water after rain was all that could be expected.

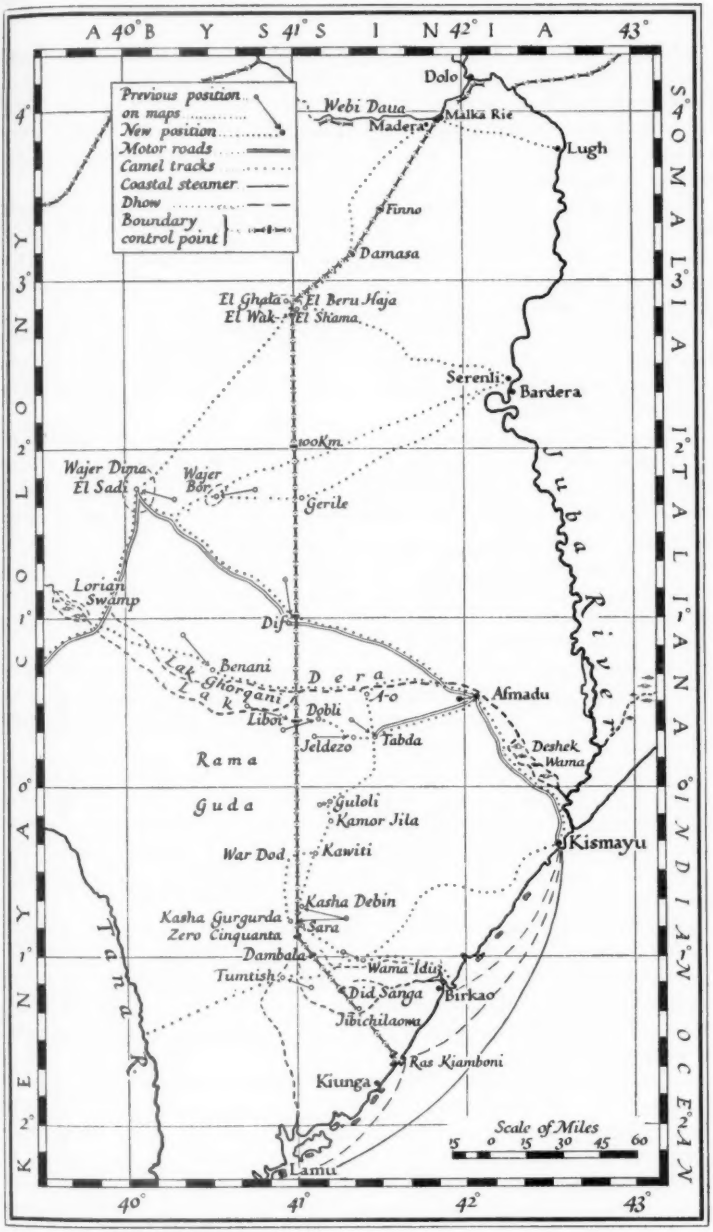
In a country overgrown for the greater part with dense bush and harbouring nomad tribes by whom trespass and pillage were considered virtues, it seemed obvious that, in the interests of subsequent administration, the boundary should be demarcated most clearly. The British proposal that it should be marked throughout its length by a lane cut through the bush was accepted by the Italian Mission after long deliberation.

Further arguments in favour of the proposal were that such a line would be unmistakable to the local tribes, that the bush was of a very slow-growing variety, that the lane once cut would undoubtedly be kept open by natives driving their stock between pasturages, that it provided the first element of a motor road, and that it assisted the boundary survey.

On first consideration it appeared reasonable that triangulation might be adopted with profit in the north, that accurate traversing would be necessary elsewhere, and that the whole should be stiffened by astronomical determinations of position and direction. On closer examination it transpired that triangulation was inadvisable for both technical and economic reasons. Technically it failed as a proper scheme, in that plane-tabling was impossible owing to the universal thorn bush, and the topographical detail, consisting chiefly of tracks and water-holes, could best be tied to points on the actual boundary-line by traverse. Economically it failed owing to the difficulty of rapid transport, supply, watering, and defence measures for the various parties in this dry and inhospitable country, where concentration of force and effort was clearly indicated.

It was therefore decided that all the main control points should be fixed astronomically in combination with wireless time signals, and that the topography should be surveyed normally by compass traverse, supplemented when possible by the plane-table or theodolite, and that a key for the topography should be obtained by running a taped traverse between main control points. The resulting field sheets were to be on the 1:100,000 scale with a vertical interval of 30 metres, and were to cover a strip of country extending 4 kilometres on either side of the boundary-line. Both Missions were to fix the main control points sympathetically, but the topography between El Wak and Malka Rie was to be shared, as an experiment, each Mission being responsible for its own side of the boundary, a scheme which was very soon discarded.

Having made these weighty decisions, the Italian Mission proceeded to El Wak, whither I followed them shortly in company with Mr. Kane. Captains Clifford and Erskine remained behind at Wajer until the supply question was completely solved. At El Shama I made the first astronomical fixation jointly



The New Western Boundary of Italian Somaliland

with the Italian Mission, and Sergeant Foster with a self-contained unit started cutting and beaconing the boundary-lane in a southerly direction. I then proceeded to Damasa and fixed that point astronomically in conjunction with my Italian colleagues, returning to El Wak in time for Christmas celebrations. Sergeant Foster's party then reversed the direction of its work and started cutting towards Damasa.

Meanwhile the Italians had fixed Dolo and Malka Rie, and we shortly followed suit with regard to the latter point. The fact that there was no most southerly bend of the river at this place did not seriously upset matters, as the Commission quickly decided on a convenient starting-point for the boundary which would leave Malka Rie in Italian territory.

No sooner was this last operation completed than Lieut.-Col. Dotto informed me that his local Government considered his programme of work to be too generous in every direction, and had given him definite instructions regarding curtailment.

I immediately cabled home to the Colonial Office requesting support for the fuller proposals, and arranged with Lieut.-Col. Dotto a temporary scheme which would permit of reversion to the original programme if matters shaped their course as we hoped. The British were to fix a point near the hill of Finno alone, and one or two points to the south of El Wak in conjunction with the Italians. The Commission was then to leave the British non-commissioned officers surveying and demarcating in the north (though of course Lieut.-Col. Dotto did not participate in these instructions), and to proceed to Ras Kiamboni, where the boundary breaks out to the coast.

Immediately after having made this compact, Lieut.-Col. Dotto was compelled, through ill health, to break off his connection with the Commission and return to Italy. We were all very sorry to lose our courteous and friendly collaborator.

The interim programme which we had arranged was of necessity further abridged after the fixation of Finno, as the Italians found their transport and supply in such a bad state that an immediate return to Kismayu was imperative. The British Mission moved via Wajer, Dif, and Afmadu, and at the latter place met the new Italian Senior Commissioner, Major Aniello Napolitano.

On 3 April 1926 the joint headquarters was assembled at Kismayu, and on the 8th the High Commissioner called a conference at which he informed the Commissioners that the Italian Government had reconsidered its views regarding the survey and demarcation of the boundary. He then advanced certain proposals which were sufficiently close to those originally formulated to warrant my acceptance.

We then sailed by dhow for Kiamboni, leaving Captain Erskine behind to purchase more camels, and to close the Wajer base in favour of Dif. The work at Kiamboni involved the selection of a point on the headland on to which the boundary-line emerging from the interior would be directed, to fix this point astronomically, to unite the small islands and various other points in a small triangulation scheme and to demarcate the boundary in its small deflection near the coast. All this was completed by the end of May 1926, when we returned to Kismayu. My companions then proceeded to Dif,

where they resumed work. I, unfortunately, was put out of action for some time by ill health, and was unable to join headquarters before July 13, when I found the situation as follows: The British non-commissioned officers had completed survey and demarcation to a point 100 kilometres south of El Wak, and had then betaken themselves to Dif some days in advance of headquarters for economic reasons. About 90 per cent. of the camels had died, and Captain Erskine was still struggling with the replacement problem. Captain Clifford, in conjunction with the Italians, had fixed a control point. Lieutenant Holmes had relieved Lieutenant Watson in command of the escort.

It was then decided that the British Mission should fix a control point where their non-commissioned officers had interrupted their work, that survey and demarcation should be continued thence southwards by this latter party, and that the Italian Mission should survey and demarcate northwards and southwards of Dif with two field parties. These decisions were then put into operation.

As soon as the two parties working north of Dif had joined hands, the Italians accepted responsibility for demarcation and survey southwards as far as Zero Cinquanta, whilst the British were to complete the line from that point to the sea.

Based now on Tabda, the British fixed the Liboi point alone, the Guloli point in conjunction with the Italians, and the Dambala point alone. The non-commissioned officers, who had been filling in time with a little work on the line at Guloli, were then put in at this last-mentioned point and started working towards Zero Cinquanta.

At this period the transport question began to assume the difficulties that had been predicted, our camels dying at the rate of approximately one per diem owing to infection by "baal" fly. The water question was also becoming somewhat alarming as the local rain pools were reduced almost to mud, and the "short" rains, which were long overdue, threatened to fail completely.

Towards the end of October the two headquarter parties assembled at Zero Cinquanta, and by November 5 this important control point was jointly fixed. From this date immediate contact with the Italian Mission was lost until the end of their field activities.

The British headquarters remained at Zero Cinquanta until their demarcation party had closed on that point. Both parties then moved south-east, the former proceeding to the Italian post of Wama Idu, where a base had now been formed, and the latter cutting from Dambala towards the sea. The rains had now broken, and the flat parched land became a veritable morass, thus rendering the supply duties, with rapidly disappearing camel transport, increasingly difficult.

Abreast of Wama Idu the nature of the vegetation changed completely, the normal Jubaland bush giving place to occasional large grassy expanses. In such instances the "cut" was not considered to be sufficiently impressive and was therefore supplemented by intervisible cement pillars.

At this time Lieutenant Holmes, the escort officer, very kindly volunteered to proceed to Lamu, there to recruit labour, himself start a fresh No. 2 demarcation party working from the coast, and at the same time to replenish the labour suitable for No. 1 demarcation party. This proposal I gratefully

accepted, and after receiving instruction for a few hours in the use of a theodolite, Lieutenant Holmes started on his special mission. Meanwhile the British headquarters proceeded to "cut-head" and there, alone, fixed the control point Did Sanga.

Since many tales were current as to the inhospitable nature of the country ahead, Captain Erskine set out on a reconnaissance from this camp, and after working his way with a compass through almost impenetrable bush, he joined hands with Lieutenant Holmes, who was well started on his task of demarcation, and returned to camp on Christmas Day with most valuable information, including traverse sketches. The report which was credited by the native staff that there existed a dense forest, harbouring masses of ferocious elephants and buffalo, was apparently mythical, though the vegetation was certainly very much thicker than had been experienced hitherto, and contained patches of trees of considerable girth.

On December 30 I quitted the field party in order to confer with Major Napolitano at Kismayu, and left the conduct of the technical work in the hands of Captain Clifford: the supply, transport, political and other services being under Captain Erskine as hitherto. Mr. Kane quitted the field at the same time, as his most admirable work in connection with wireless reception was now completed.

Major Napolitano reported that the Italian demarcation party had reached Zero Cinquanta on December 12, that the whole Mission had then returned to Kismayu, that Captains Marino and Bertacchi had sailed for Europe in January, and that he was due to follow them on February 9. It was then arranged that the Commission should reassemble in Florence early in May 1927.

On February 3 I took steamer to Lamu, whence I proceeded immediately to Kiamboni in order to establish touch with my field parties. I found that Lieutenant Holmes of the escort had cut 17 kilometres of the boundary, unassisted by any other Europeans, and that he had held his direction with accuracy, the whole constituting a performance of great merit. The direct result of this officer's action was a saving of approximately one month in the duration of the work. On February 10 the junction between the two working parties was effected, and on February 18 I dispatched a telegram to the Governor of Kenya to the effect that the boundary was then completely demarcated.

The evacuation of personnel and stores to Kiamboni was effected by February 24. This was mainly by porter transport, as, owing to disease, less than twelve very weak camels remained out of some 250. Lamu was reached by dhow on February 25.

From February 25 to the dates of sailing in early April the Mission busied itself in Lamu, Mombasa, and Nairobi with sales, packing, accounts, etc., and with the preparation of tracings of such portions of the boundary survey as were effected by itself. The British non-commissioned officers sailed from Mombasa on 2 April 1927, and thus concluded their labours with the Commission. Four days later Captains Clifford and Erskine and I set sail from the same port for Italy.

On April 28 the Commission resumed its duties in Florence, and as the

Wireless receiving set

One of the A-o wells

"River Durnford"

Jirma

Water-pits, Baghtili, Mada Marodi

Boundary pillar on coast, south of Ras Kiamboni, and islets of Dhi
Dhamashaka

majority of its members were at this time accredited to the Senior Commission also, they found themselves confronted mainly with political business. Of boundary work there was little more to occupy us beyond the plotting of the Italian field work and the reproduction of the final map. General Vacchelli very kindly accommodated us all in the Istituto Geografico Militare, of which he is the Chief, and our grateful thanks are due to him for this courtesy and for undertaking all the processes of reproduction from the fair drawing to the final printing of the map.

The end of my narrative appears to be a fitting place to say that our relations with the Italians were of the most friendly, and in some cases almost affectionate, nature. It would take much to efface the memory of the impartiality and friendship of H.E. Signor Zoli both in Africa and Italy, the kindness and hospitality extended to us by the Officers' Club in Kismayu, by Lieut.-Col. Costa at Serenli, by the Marchese della Stufa at the humble station of El Beru, and by the administrative officers of Afmadu. Within the Commission we were the happiest of families, free from the usual international suspicions, and it would be a sad day for me were I to know that I would not see every one of these good friends again.

Finally, I would say a word regarding the help afforded to the Commission by our own people. In Kenya I found most ready assistance everywhere, but there were certain individuals who added a large measure of personal interest and friendship to what might otherwise be considered as a duty. My friends of olden days in the Survey Department, Mr. Baker and his staff officer Mr. Williams, did not always wait to be asked but often sought ways in which they might help us. Captain Mahoney at Wajer, well-nigh swamped with work due to the coming change of administration, dreaded the approach of the Commission, and yet when we materialized he was most open-handed in his hospitality and general help. Captain Legge, and later Mr. Pease, at Madera made us thoroughly realize that to help us was a real pleasure. Mr. Platts was of very material assistance to us over the question of labour in the later stages of the work, and he and his wife extended to us the first hospitality of real civilization whilst we were winding up affairs in Lamu. Mr. Doherty in his capacity as Government Coast Agent at Mombasa must have thought unkindly of us on many occasions, as we threw a very heavy burden upon him with respect to general agency services. Lastly I mention my good friend Mr. Dick, the whilom British Consul at Kismayu, who most willingly, and quite outside the call of his office, performed most laborious duties for us, and who ever held the doors of his bungalow at Halwalud wide open to any member of the Commission. As regards the members of my staff on the Commission, I would like to give full rein to my praise, but let it suffice that one and all gave of their very best under most trying conditions, and by their excellent team work and unfailing loyalty brought to a successful issue a small task in the interests of Empire.

APPENDIX A. TRANSPORT AND LABOUR

Two main supply bases were established, at Wajer and Kismayu, and the lines of communication connecting these with the civilized world and also with the advanced bases, are shown on the map. Connection between the advanced bases and the field working parties was effected by camel. Europeans were

mounted on mules whenever possible, but this was rarely the case when actually in the "cut," owing to the water shortage.

Owing to the insufficiency of camels in the Wajer District, permission was obtained for purchases to be made at Serenli to the extent of 100. At a later date the full complement of 250 and replacements had to be made good from the very scanty supply available in Kenya. A camel troop comprised 50 beasts in the charge of two Lance-Naiks, and each syce was responsible for three camels.

In the north animal mortality was very light, but directly the southern area was reached and the *baal* fly season began, deaths amongst the camels that had to be kept in the infected zone developed enormously and eventually resulted in the almost complete extinction of our animal transport. In the last stages of boundary demarcation a tsetse belt was encountered, and this caused the deaths of the remaining riding-mules, which had necessarily been converted into baggage animals some time previously, and of the two donkeys which had been bought in an effort to save the situation. The final extraction of the working parties was actually effected by the natives who had been cutting the boundary.

As regards labourers, the greatest difficulty was experienced in inducing any of the Bantu tribes to leave their comfortable well-watered lands and to face the waterless regions of Jubaland and the hostile and aggressive Somali tribes, of which they lived in constant fear. The Somalis themselves, who overran the whole territory, were far too proud to undertake any sort of job entailing manual labour. The first consignment of about twenty-five men was enlisted in Nairobi, chiefly from "corner" boys, as the better class of native preferred the higher wages to be obtained on shooting expeditions. However, a course of regular work combined with good feeding and strict discipline changed a somewhat miserable-looking gang into a cheerful, contented, and well-developed brotherhood of hard workers. After a year of continuous employment this gang was relieved by another, recruited by Mr. Platts, the District Commissioner at Lamu, which served for the remaining six months of the field work. Fresh drafts were added towards the end of operations, thanks again to the kind services of Mr. Platts, assisted by my escort officer, Lieutenant Holmes.

As special police, eight members of the Jubaland Armed Constabulary (Somalis) were retained on disbandment of that corps. This small body proved itself most efficient, well disciplined, and trustworthy. They were used for policing the camp and for making small purchases of livestock for both food and transport.

It was deemed expedient, for many reasons, but largely on account of the doubtful attitude of the local tribes, to clothe the entire native staff in uniform, and to place them under strict military discipline. All N.C.O. syces bore arms.

APPENDIX B. SURVEY INSTRUMENTS

The wireless receiving set was specially arranged by the Marconi Company at the shortest of notice and served its purpose most admirably. The details of the set were as follows: A four-valve long-wave heterodyne receiver of range 10,000–25,000 m. Two transformers were of ratios 1 to 6 and 1 to 7 respectively. Condenser was of 0·001 mfd. value. The set was mounted in a strong teak box, 21 in. × 12 in. × 12 in., of total weight 20 lbs.

The valves used were "Weco" with American type base, manufactured by the Western Electric Co., Ltd., now the Standard Telephones and Cables, Ltd. They were found very satisfactory, and owing to the small consumption of current (0·25 amp.) highly suitable for working off dry cells. They are very robust, and being small are easily packed for transport.

The headphones (Sterling 4000 ohms), supplied by the Marconiphone Co., Ltd., were entirely satisfactory.

Messrs. Siemens Bros. & Co.'s Type No. 53 Inert Cell gave satisfactory results for filament batteries, but did not stand up well to the roughness of camel transport. It was frequently found that the positive element inside the cell was broken.

Smaller cells by the same firm, Type No. 53, were found to be excellent, and were also used for theodolite diaphragm illumination and for azimuth lamps. They are very light and therefore easily transported, even by porter.

Silvertown I.J. Inert Cells, supplied by the India Rubber, Gutta Percha, and Telegraph Works Co., Ltd., were used for high-tension batteries and stood up well to the work and conditions.

The aerial used was 100 feet of 7-strand bare copper wire, with a lead in of 20 feet.

A 20-feet ash mast, in two 10-feet sections, was used during the first six months, but had to be abandoned to relieve the transport.

The earth terminal was connected to a 3-feet copper tube driven into the ground a few feet from the receiver.

The chronometer was by Thomas Mercer, a special type, non-swinging, with a microphone arrangement by means of which the half-second ticks were made audible in an ordinary headphone. Although this timepiece did not exhibit a very good rate, it served its purpose most admirably and was largely responsible for the good results obtained in longitude determinations.

The chief theodolite, which was used almost entirely for astronomical work, was an 8-inch micrometer type, by Troughton & Simms. Mr. A. G. Baker, the Director of Surveys of Kenya, very kindly lent me this instrument, but I am afraid I cannot give it a very good character, as the trunnion supports had spread and caused us much trouble.

The remaining instruments and also the camp equipment were of types to be found on any normal survey expedition, and I do not propose to occupy time in a description of them.

APPENDIX C. SURVEY AND DEMARCATION

The control of the boundary survey was based primarily on determination of position and of azimuth effected astronomically in combination with wireless time signals. These fixations rarely occurred actually on the boundary-line, but were connected thereto either by a traverse or by a small local system of triangulation. Subsidiary control was provided by surface measurements along the boundary-line adjusted between main control points, direction being maintained by means of a tracing theodolite. The value of a control point was much enhanced if its fixation was effected in advance of demarcation.

When the British and Italian Missions co-operated in fixing a point their camps were within reasonable distance of each other, and the comparisons of their results were made by means of short theodolite traverses.

All British latitudes were measured by the circummeridian method, time by east and west stars, and azimuths by altitudes of stars on or near the prime vertical. Longitudes were obtained by the ordinary relative method, *i.e.* the difference between the chronometer errors on local and Greenwich times at the same epoch.

The night's programme was generally so arranged that the results of the time observations when meaned gave the chronometer error exactly at the epoch of wireless comparisons, thus obviating the necessity of considering the rate of the chronometer.

The method of measurement of chronometer times during a time observation was possibly original. The chronometer stood on the booker's table. The observer wore a headphone by means of which the chronometer beats were brought to his ear, and he was thus able to measure the time of the star's passage as well as its altitude, though the responsibility was shared to a certain extent by the booker. The procedure was as follows: Shortly before contact the observer gave the warning "stand by," and, slightly later, "time." The booker then called out the values of three successive second beats as 2, 3, 4, or 9, 10, 1, never calling a higher value than 10. The observer, having picked up the beat value, continued the count himself, recommencing at 1 if he should have occasion to pass 10. Immediately after contact he called his time to the booker to the nearest decimal of a second. It was the job of the booker to watch the chronometer so that he could complete the value called by the observer, with regard to the particular group of 10 seconds in which it fell and also with regard to the correct minute.

Wireless telegraphy was employed primarily for the reception of the long-wave time signals, but also for press, and latterly for the interception of telegrams addressed to the Commission.

The time signals employed throughout were the rhythmic series of Paris Observatory transmitted by Bordeaux (LY). These fitted in very conveniently at about 22 h. 30 L.M.T., in the middle of astronomical observations, while the morning signals provided a most convenient check on the chronometer. These were also the strongest signals emitted from any station.

The series transmitted by Lyon (YN) were tried several times in 1925, but were weaker. They were discontinued in 1926. Those from Nauen (POZ) were also tried, but were inconvenient, as at 14 h. 30 L.M.T. interference from atmospherics was often considerable, and by 2 h. 30 astronomical work was long since completed.

The new procedure introduced by Paris Observatory in 1926 was a marked improvement on the former system. Reception and comparisons were facilitated, while computations were considerably simplified.

In the earlier stages of the work time signals were taken in the operator's tent, but as this involved carrying the chronometer backwards and forwards from the astronomical station in the middle of the observations, a 100-feet headphone lead was later utilized to enable the signals to be received at the booker's table without moving the chronometer.

Atmospherics were less of an obstacle than had been expected. On only one occasion did they prevent the reception of the time signals. They were at their worst about a month prior to the breaking of each rainy season, but once the rains had broken there was no serious interference. From 14 h. to 22 h. L.M.T. was the worst period of the day, after which atmospherics gradually died off until at 2 h. 30 L.M.T. they were almost nil.

Rugby annoyed us excessively by sending out press at 20 h. G.M.T. Until the rhythmic beats of the time signal from Bordeaux started, Rugby was silent, but simultaneously with the start of the beats Rugby opened up, and, owing to its power and the insufficient difference in wave-length, could not be eliminated, tuning out at such a period not being feasible with our receiving set.

As I have already stated, the wireless comparisons were effected by means of the rhythmic series of signals emitted from Paris Observatory via Bordeaux. With the apparatus at our disposal we were able to bring the Paris signals into one ear-piece of a headphone and the local chronometer ticks into the other, thus rendering the recording of synchronizations an easy matter.

As regards the results of our fixing of control points, interest will naturally

focus on the determinations of longitude. Twelve points were fixed, astronomically, on the line (*vide* the map). The mean number of independent British values obtained at a station was 3, and the mean extreme range at any one station was 00·26s. The Italians co-operated in fixing seven of these stations, the greatest discrepancy between their values and ours being 211 feet, the least 5 feet, and the average 54 feet. Each longitude value depended on eight observations for time; four before and four after reception of time signals. Captain Clifford and I shared the observing and booking about equally, but the responsibility for each individual value of the longitude was not divided.

I will now discuss the processes of demarcation and survey simultaneously. The progress of the party responsible for these two duties I have already related in my general narrative. The actual line was driven by theodolite with the greatest care. In view of the fact that the main control points were fixed astronomically, it could not be expected that two demarcation parties approaching each other from opposite directions should exactly meet without some final adjustment of direction. The procedure generally adopted was as follows:

When the two parties were separated by about 8 kilometres, a Verey Light was fired at night from one of the "cut heads" and was observed through a theodolite set over one of the alignment pickets near the other "cut head." Then, on the assumption that both parties had been preserving the correct azimuth, both directions were equally deflected in accordance with the angle observed with the theodolite. This procedure was repeated when the "cut heads" were about 4 kilometres apart. The final adjustments were made in one or more corrections based on observations to a flag on a tall pole.

Measurements along the boundary-line were all surface measurements, effected with an ordinary steel tape. All crossings of tracks were noted in passage, and these served as a control to the topographical work.

The ordinary compass sound and wheel traverses were adopted in the first instance for surveying tracks and other detail. These traverses when plotted were adjusted to fit control points. The British non-commissioned officers, however, soon developed a system which tended to greater speed. They first trained themselves to a uniform rate of walking, and then by experiment established a time scale which automatically absorbed the increased length of each leg due to curves met on the track, and allowed them to plot direct on to the field sheets. It was found that the normal traverses fitted the control work without further correction.

The form lines defining the relief of the country were based on barometric heights, corrections being taken from a table prepared by the non-commissioned officers after careful observation of the diurnal wave.

Plane-tabling could not be adopted except in the hilly country towards the north and on the coastal belt, the flat plains elsewhere rendering it quite inapplicable.

The total length of the boundary is 681 km. Of this 407 km. were demarcated by the British Mission and the remaining 274 km. by the Italian Mission. Each mission made a topographical survey along those portions of the boundary which it demarcated.

The lane which was cut throughout the length of the boundary was approximately 12 feet broad and clear of all loose brushwood, but, in the first instance, was not cleared of stumps. However, since the departure of the Commission from Africa, much of this lane has been adapted to a motor road. In addition to cutting the lane, the demarcation parties distributed pillars and cairns throughout its length. Main pillars were built at both terminals of the boundary, at all pivotal points, and at approximately every intermediate interval of 30 kilometres.

These were numbered consecutively from the north. Each pivotal pillar was furnished with two small pointer pillars, one set in each direction of the boundary. One large cairn was built where the boundary passes the flank of Finno. Small cairns and pillars were built at approximately every 10 kilometres and elsewhere to accentuate the boundary where it crosses tracks of any importance and also where it crosses grassland in which the lane becomes ill defined. The map produced by the Commission shows the particular type of beacon used in each instance.

In the north the pillars were built of rough stone set in cement, but in the south they were rendered more shapely by building them within a wooden mould. In some cases the cores had to be made of tree-trunks and even of bottles owing to the absence of stone.

The spelling of place-names for the Boundary Map presented a problem that was not settled for some time, as the Italians are not familiar with the R.G.S. II. system, and Italian spelling would be meaningless, or even misleading, to most British officials. The problem was rendered more intricate by the fact that five different languages were involved. It was ultimately decided that for the names of places lying in British territory the R.G.S. II. system should be used, and Italian spelling for those in Italian territory; while important localities, such as El Wak, lying astride the boundary, should be given in both methods. This decision, carrying with it the preparation of a gazetteer, entailed an enormous amount of work on the part of Captains Erskine and Clifford.

The following are some examples of divergence between the two systems of spellings:

R.G.S. II.	*Italian.*
BAKAJA OBE	BACCHEG OBBE
BUBUSH	BUBUSC
DHIWA DHAMASHAKA	DIUA DAMASCIACA
GHAIYAG	HAI-IAGH
GHAWL	HOHL
JINJILI	GIÈNGIOLE
KITUNGENI	CHITUNGHENI
NYURA	GNIURA
YAQALI	IACLE

Note by Captain Clifford.

The river name which we have spelled Daua is given in the First List of Names in Abyssinia, published by the P.C.G.N. as Dawa, pronounced Dáwā, with the warning " not Daua." This pronunciation is certainly not correct near the Kenya frontier. The name is pronounced as the first two syllables in "dowager," the second being nearly mute, and should by the P.C.G.N: rules be Daua. It may not be an Abyssinian word.

The present inhabitants of the area between the Juba and the river in question—*i.e.* north of the latter—are Somalis, but they are of course comparatively new-comers, having displaced Galla tribes. However, many of the place-names in that part of the world are Somali, not Galla.

We got our names into shape by means of a Committee, consisting of two officers (one of whom knows a little Somali), cross-examining an assortment of natives selected from varying tribes and sections, and including Somalis from British Somaliland. For pronunciation we went by the local people, provided the various tribes and sections agreed, and then followed a discussion of the language and meaning of the name until all were agreed. In this way we

took advantage of tribal jealousies—agreement would not be reached unless the statements were correct.

"Webi," is certainly Somali, possibly a dialect. But it is a word one frequently meets, *e.g.* Webi Shebelli, the main source of irrigation of Italian Somaliland, which means "the river of the place of leopards." "Daua," as far as I can recollect, was not quite "Look at it," but perhaps rather "Look," or "Behold." This is also perhaps a dialect, but was emphatically stated to be Somali. The Somali language has plenty of dialects.

NOTES ON JUBALAND: *Read in part at the Meeting of 7 May 1928 with the preceding paper, by*

CAPTAIN E. H. M. CLIFFORD, M.C., R.E.

THE outstanding characteristic of the topography of Jubaland is its featureless flatness. At Dolo, where the Juba leaves Abyssinia on latitude 4° 10′ N., the altitude is only just over 200 m., though the mouth of the Juba is on latitude 0° 15′ S. The greater part of the country is covered with thorn bush, on the average about 11 to 12 feet high.

To consider the country in greater detail. At Malka Rie on the Webi Daua the altitude is about 300 m. Proceeding southwards we climb gradually through Gogal until reaching the northern escarpment of the Dirhara plateau, the western edge of which coincides with the boundary, and along which lie the highest points—about 700 m. altitude. We then drop gently until reaching the southern escarpment which takes us down from 500 m. to 300 m. In this zone, just in British territory, lies Bur Wein, probably the highest hill in the country, 825 m. This escarpment is quite rugged, though covered with dense thorn bush.

We now reach the plain of Central Jubaland, very gently undulating. As we progress southwards, we see less and less camel thorn and the bush is generally less dense. About 1° N. we meet a new feature, a "lak" or watercourse—dry, of course, except after heavy rain—in the bed of which the vegetation is denser, but of a sappy nature and mixed with long grass.

The Lak Dera basin runs roughly east and west about 0° 30′ N. through a zone of open spaces. This watercourse is shown on the map quite rightly as an important water feature; but water ran in it in the summer of 1926 for the first time for twenty-two years. Its course is shown entirely incorrectly on hitherto existing maps.

South of the Lak Dera on the British side is Rama Guda, uninhabited and feared by all natives as a veritable " land of thirst."

About 0° 50′ S. we enter another zone of open country, park-like and traversed by a number of "laks," some open, some bush-covered, ending abruptly at a belt of extremely dense sappy forest known as the Bada. In the middle of this is a gap, in which lies the Durnford River of the older maps, actually a well-defined watercourse whose only name is the Lak. The Bada gradually gives place to a forest of "bean trees," which in turn yields to thorn bush on reaching the coastal hills. These rise to about 60 m. and are some 10 km. across.

The coast is of dead coral, with a protecting reef, inside which is a chain of islands. Kismayu Bay is well protected, with a tricky entrance, but unfortunately ships have to lie far out. Birkao (the Port Durnford of former maps) has quite a fine estuary of fairly deep water.

The vegetation consists principally of "cat thorn," flat-topped mimosa, euphorbia and syringa trees, and sundry sappy bushes whose names I do not know. There are baobabs in the centre and south, increasing in frequency towards the south. Camel thorn and a small flowering aloe are features of the northern part of the country, while sansaviera and a euphorbia plant called "galileo" by the Somalis are characteristic of the south.

The forest of bean trees already mentioned contains rubber vines, which some years ago employed quite a number of men tapping and carrying to the coast.

One must not forget the dense belts of doum palms along the Webi Daua and the Juba, or the scattered coconut palms along the coast. In Kismayu there is a curiosity that seems worth quoting—within a space of 30 yards one finds a doum palm, a coconut palm, and a date palm.

One cannot help being struck by the way in which a single shower of rain is sufficient to cover the thorn bushes in leaves, a most heavenly relief from their grey, dead appearance at the end of either dry season.

The country is very dry, with an average annual rainfall of about $7\frac{1}{2}$ inches, but it is as well to emphasize the word "average." It lies within the monsoon zone, and there are four seasons—mid-March to June, the "long" rains, followed by drought till the "short" rains break in September or October. Then comes "Jilal," December to March, when the maximum heat is reached. There are sometimes odd light showers in July or August, a phase known as "Hagai."

But the essence of the whole problem is irregularity. Thus in 1923–1925 all rains failed. But the short rains of 1925 produced $8\frac{1}{2}$ inches. Another most important point is the local nature of rain; so much so that one is tempted to draw a comparison with cloud-bursts.

The Juba is permanent, but only navigable after the melting of the snows in Abyssinia. The Webi Daua is dependent on the rains, but one can get water at all times by digging. For some time after the rains water can likewise be got by digging at suitable spots in most of the torrent beds of Northern Jubaland. I believe I am right in saying that there are no springs in the country.

Just south of Malka Rie there is an important group of sweet-water wells at Qoriamo.

The area of El Wak is riddled with irregularly shaped vertical shafts—fissures developed probably by natural causes—from which galleries run to water. Most of these have been allowed to silt up. Those that continue in action are super-highly mineralized, and one is tempted to suspect superstition or cynicism in the name "The Wells of God." I believe firmly that this mineralization is due essentially to accumulated filth. But the water is anyhow extremely hard.

Here, as in wells of a similar nature farther west, the water is passed in giraffe-hide buckets by a human chain, often with the best-looking girl avail-

able as the well-head link, singing to the other links that they work incredibly slowly.

When the natives return to these wells in the dry season, the accumulation of sulphuretted hydrogen in them is dangerous. A girl is therefore sent down first to bale out gas until the concentration has been reduced sufficiently to be reasonably safe for the more valuable adult males.

Wajer Dima is another large group of permanent wells of much better water. Again the majority have been allowed to fall into disuse, and cleaning is more difficult as they average probably only about 2 feet in diameter by 30 odd feet in depth. They were undoubtedly made by human agency. But how? A now extinct race, the Wadenli, are credited with the job.

There is a small group of wells at Katulu, similar to the last, but almost out of action.

Wajer Bor is yet another cluster: the shafts are larger and more open than those of Wajer Dima. They have been going more and more out of action in recent years. We cleaned 15 feet of evil-smelling filth out of one, and converted an almost dry well of most unpalatable water into a generous supply of good, though hard, water.

Just out of the bed of the Lak Dera is A-o, where there are seven great conical holes in the ground, in the bottom of which is permanent, if muddy, water. Afmadu has a pit that is somewhat similar. In both cases the supply has to be handled carefully to give time for recovery.

The wells dotted along the coast are mostly salt. Thus at Birkao fresh water is brought by dhow from Bubush, about 24 km. away up the creek at the limit of salt water.

For the greater part, however, one must look to the water-holes for one's water supply. They get pretty foul, mainly from stock, and by the end of "Jilal" are generally thoroughly "fruity," as well as muddy. They vary in size from the smallest depressions to fair-sized lakes such as Damasa, Dadabli, Yaqali, Tabda, and Wama Idu. Some are of natural formation, but many are artificial, ascribed, like the wells of Wajer, to the labours of the Wadenli. The larger ones often hold water throughout the year after normal rains. We had, in consequence, hoped to be able to draw on Wama Idu; but when we got within reach of it, it was bone dry.

In July 1926 we were obliged to take water-conservancy measures near Dif, and dug several reservoirs into which we drained the water, frogs, and fishes of the neighbouring water-holes, and protected them from the sun with brushwood. All went well until one night a hyena fell into one of them, and, still more regrettably, had to be shot in it. That water defied description!

We carried water by camel in the army-pattern steel rectangular tank of 12½ gallons capacity, which weighs 175 lbs. when full. This is known locally as a "barramill." Two of these are a heavy load for overworked animals. We also had a good number of "chaguls," which were monopolized by the two European messes and the Bantu labour, who were allowed one a head. In addition, of course, every one had a water-bottle.

The water ration was unlimited whenever possible, in particular for the Bantu personnel. In times of scarcity, however, it was limited to about

½ gallon a day, Europeans being allowed up to as much again for toilet purposes.

The hills of Northern Jubaland are, I think, laterite, and they are all flat topped. El Wak, Wajer Dima, and Wajer Bor are limestone outcrops. Otherwise there is no stone on or near the surface. The soil is of four main varieties: red soil like most of East Africa, soft red sand, black cotton soil, and "rotten ground," which to the inexperienced often seems rather similar to cotton soil. It is this cotton soil which provides the possibility for development—by irrigation from the Juba.

Thanks to being astride the Equator, and to its bush, Jubaland has a very even temperature. I never saw the thermometer as low as 65° F. at night, and I never read a shade temperature in my tent higher than about 95° F. But I have been assured that, for instance at Serenli, it goes up to 120° F.

There is no dysentery, and one is only exposed to danger of malaria when there is water about—that is to say, during the rains and when close to surface water. But it is a hard climate, and one must have a good constitution to resist it; above all, sound nerves are needed to compete with the intense dry heat, particularly during "Jilal" with its stifling puffs of wind in the middle of the day, and the eternal bush and absence of view.

The inhabitants of Jubaland are mostly Somali, who only started crossing the Juba about the beginning of this century, driving back the various Galla tribes. A certain contamination has resulted, mainly of course among the earlier arrivals now in the south and west. Their language has suffered quite a lot, and among other things they have adopted is the African habit of shaving the head. Now one precept of the Koran with reference to health is "keep thy head covered and thy feet bare." The Jubaland Somali succumbs frequently to fever; but it seems far more likely that the trouble is not malaria but sun, due to the loss of the enormous sun-proof mop of hair which he wore in his country of origin.

The Jubaland Somali is evidently inferior to the Northern Somali. But he is distinctly superior to the races in his immediate vicinity.

Somali tribal organization is exactly comparable with that of the Scottish clans, and a Somali has extraordinary aptitude in genealogical discussions. Tribal and section jealousies are intense; but their "style is badly cramped" these days by the troublesome Government with its annoying habit of inflicting punishments for raiding.

The Somali is essentially a camel-owner, and the northern half of Jubaland is good camel country. But from about 1° N. southwards a variety of "tabanus" fly, called "baal," appears in swarms with the rains. A camel bitten by "baal" may survive if given complete rest for something like six months. If he recovers he is thereafter immune. Most die. Consequently one only sees an occasional camel in the southern half of the country, and the stock there is entirely cattle, fat-tailed sheep, and goats. The Somali feel this indignity acutely; the Northern Somali always laugh at their unfortunate cousins of Southern Jubaland.

The Jubaland camel has one great advantage for military and similar purposes—he requires no rations, but lives on his grazing. This of course saves an enormous amount of transport. His carrying capacity however is only 300 lbs.

The northernmost tribe in Jubaland, the Marehan, have ponies as well. It is curious that, for all their pride in their stock, with none of it have the Somali any ideas on selection for breeding.

The only Galla tribes now in the proximity of Jubaland are the Gurreh, Boran, and Sakuye, all pagans. They are far inferior to the Somali in all respects. The Gurreh in particular are the world's best passive resisters and most aggravating folk to administer. They are eternally being raided by Somali tribes from Abyssinia. So, some years ago, the kind British Government gave them some rifles. After the next raid they were asked why they failed to use their rifles in self-defence. "We haven't got any." "How's that? Where are those you were given?" "Oh, we sold those some time ago." "To whom?" "To the Abyssinian Somali who raid us."

Along the Juba south of 2° N. are a small race, the Wagosha, negroid and pagan. These are the only labourers available in Jubaland.

Along the coast from Kismayu to Lamu is a race of very mixed blood, the Bajun, living mainly, as far as Jubaland is concerned, on the islands, where they took refuge from the Somali invasion. They speak a dialect of Swahili, and are Muhammadan. They are fishermen for the greater part.

Finally there are the Bon—a Somali word meaning "outcast." These are all that remain of a primitive race, very similar to the Australian aborigine. They are absolute animals and have, for instance, no sense of possession. They live by hunting, though the Kenya Government is pursuing a policy of settling them in villages and making them take to agriculture. It is most unpopular! But these people are a real menace to the game and indulge in much ivory poaching. Those to be found in Jubaland are only south of the Lak Dera, as slaves of the various Somali sections. They are the folk to get for guides and game-tracking, but are shy and very difficult to handle.

Both Somali and Galla live on milk—if possible, camel milk. Occasionally a camel or bullock is killed for meat, but it is a luxury. Camel milk is excellent and most nourishing, and camel hump is delicious.

Elephant, rhinoceros, reticulated giraffe, lesser kudu, and gerenuk are distributed pretty generally; but large elephant do not often come so far east, and the rhinoceros are not numerous. The gerenuk (Waller's gazelle) have smaller heads as one gets farther away from the stony ground in the north. Dik-dik, I think Kirk's, in large numbers are all over Northern and Central Jubaland, where oryx beisa are also fairly general.

Water-buck, bush-buck, and buffalo are to be found along the Webi Daua and Juba, and also in the Bada and "bean-tree" forests.

There is a herd of Sœmmering's gazelle between Dirhara and the Webi Daua, and greater kudu are said to exist on the Dirhara plateau.

In a long narrow strip stretching from the Lak Dera west of Afmadu almost to the Tana River are the beautiful "arola" (Hunter's hartebeest). We took our toll of these, one of the N.C.O.s securing a head that constitutes a new record.

Topi hartebeest are present in large numbers in a strip from the Juba to the Tana: herds of Grant's zebra frequent the open grazing of the Lak Dera basin and Southern Jubaland; while the northern half of the Lak Dera basin is the home of numerous Grant's gazelle.

The open plains about 1° S. are full of Haggard's oribi, while between the Bada and the coast there are Harvey's as well as Common duiker.

Lion, leopard, hyena, and silver jackal are general. There were evidently hippopotamus in the Birkao basin once, for one finds the place-name Sher, which is the name of that animal in Bon language.

There is plenty of bird-life. The ostrich roams about everywhere south of Dirhara. Vulturine guinea-fowl are extremely common, replaced in the Bada and "bean-tree" forest by the elusive jungle guinea-fowl.

Three varieties of lesser bustard, sand grouse, francolin, and "bush partridge" are everywhere. One occasionally sees greater bustard, and once I saw a secretary bird. Doves are a sure sign of water within four hours' march.

On several occasions we found duck, in all some seven or eight varieties, frequently accompanied by Egyptian geese. One morning on a little beach on the Lak I saw two unusual-looking duck, one of which I secured. Despite precautions, a kite took the skin while drying. However, Captain Caldwell, of the Kenya Game Department, identified it from description as the very rare *Erismathura Maccoa*, a stiff-tailed variety belonging to the Pochard group.

One sees the Bateleur eagle, sometimes on water the white fish eagle, and the smoky ibis; and there are numerous small birds, some of them beautiful.

The vulture and marabout stork are of course the universal invaluable scavengers.

Snakes are not numerous, but they include the puff adder.

At Wajer Dima during the rains there are pink tarantula, but I didn't meet them anywhere else. They seem very harmless, and spend all their time careering about at full speed on the edge of the light thrown by one's lamp. There are two varieties of jockey spider—very gaudy and terrible looking—and in the north I found shell-backed spiders which intrigued me a good deal.

At the special request of M. Charles Alluand, the eminent French entomologist, I made a collection of beetles, among which he found five new species and one new sub-species.

I have already referred to the "baal" fly. There are also tse-tse, not dangerous to man, along the Webi Daua as far as Malka Rie, in places along the Juba, and in the Bada and "bean-tree" forests.

In Gosha there is a permanent plague of wood-lice, compared to which the invasions to be encountered at Afmadu are as nothing.

Game on both sides of the frontier is now protected: on the Kenya side by the stringent Game Ordinance of that colony, on the Italian side by a rather similar code, but not applied so strictly.

In the past, Jubaland has been very inaccessible, and the only means of movement has been by the cumbersome method of baggage camel caravan. Now, however, a number of motorable roads have been cut through the bush, and it is possible to get by car to within easy reach of any of the better shooting zones.

DISCUSSION

Before the papers the PRESIDENT (Col. Sir CHARLES CLOSE) said: Captain Clifford, who is going to address us to-night, was Assistant Commissioner on the Jubaland Boundary Commission. By that Commission and by the senior

Commission a tract of territory of very considerable area and of considerable potential value was handed over by Great Britain to Italy by agreement signed in July 1924. From the point of view of the tourist I am not sure that it is altogether very attractive country. There is a geographical generalization which perhaps might be accepted, and that is that the attractiveness of a country varies inversely as the square of the number of insects. However, I am not prepared to say much about the attractiveness or reverse of Jubaland, as I have not been there myself. We shall learn a great deal about the country from Captain Clifford. Captain Clifford's chief was Colonel King, who was in charge of the Boundary Commission which was actually to stake out the boundary between British and Italian territory, handing over the whole of the Juba river, of course, to Italy. There was also another senior Commission, a political commission, and there was a commissioner, Mr. Hope, who unfortunately died. He was originally in charge of the senior Commission and afterwards, for a short time, served under Colonel King. The situation as regards these Commissions was a little complicated, but the net result, geographically, was that the Boundary Commission staked out a line of over 400 miles through a part of Africa very little known. It did it with considerable success, and the Boundary Commission has brought back a great deal of valuable information which we certainly did not possess before. But I will not trench on the subject of the lecture. I will ask Captain Clifford at once to commence.

Captain Clifford then read abstracts from the papers printed above, and a discussion followed.

The ITALIAN MILITARY ATTACHÉ (Col. A. COPPI): Although I do not often make a speech in my own language, when I was asked to address you in the English tongue I felt I really could not refuse. I must, first of all, thank Captain Clifford for the most interesting description he has given of Jubaland, which was not long since handed over to Italy. Secondly, I should like to take the opportunity of saying that in spite of the fact that by the Treaty of London Italy was to receive very many things, England was the only nation from which she received anything, and this fact that we received something from England must strengthen the friendship that has always existed between Italy and England. Apart from that friendship which has existed through all the past centuries, there is something else in common between Italy and England. The Italians were the greatest colonizers in antiquity, and they hope to be so in the future, under the guidance of the great man at the head of the Italian Government. We are glad to know that it is possible to develop Jubaland. The English are the greatest civilizing and colonizing people at present. Thus I think the people of Jubaland should be as happy under Italian rule as they should certainly have been under British rule. I am very much indebted to Captain Clifford for the kind remarks he made with regard to the hospitality he received from my Italian colleagues, and I thank you very much for the patience with which you have listened to me whilst ill-treating the King's English.

The PRESIDENT: The long series of boundary commissions in Africa appears to be drawing to a close. We have listened to an account of the most recent of this series, a series which started after 1884. Those who read Dr. Keltie's valuable book on the partition of Africa will realize how much was left to be done when the continent first began to be carved up. Those connected with official geography have from time to time told themselves that the partition of Africa has been finished, but they have always been wrong. There is always some fresh boundary to be settled. Some little time ago we listened to an account with regard to the Wadai–Darfur boundary, and to-night we have had an account of the Jubaland Boundary Commission.

Jubaland is not a country which most people are likely to visit, and that applies to a great many of the boundary regions in parts of Africa. However, the series of boundary commissions is one of the chief means by which we have been enabled to develop, understand, and arrive at the proper appreciation of, the real geography of Africa. Some of us have little idea how very bad the maps of Africa were forty years ago. I went out there in 1895—only thirty-three years ago—and I shifted quite an important place, mentioned in the treaties, about 20 miles; others have shifted places by 20, 30, or 40 miles. Captain Clifford only shifted a place 14 miles, and that is really nothing in Africa. The result is that Africa has gradually become known and correctly mapped. There cannot be very many commissions which have done their work more thoroughly than that of which Colonel King was in charge, and of which Captain Clifford was the Assistant Commissioner. I should like to make it quite clear that Captain Clifford's work was under Colonel King, but that his lecture was partly his own and partly Colonel King's. I was unable to distinguish which was which, but we must give both equal credit for what has been an interesting lecture. In your name I thank Colonel King and Captain Clifford.

THE SEARCH FOR COLONEL FAWCETT

IN the *Journal* for February last we summarized what was then known of the expedition on which Colonel Fawcett, with his son Jack and Raleigh Rimell, started in April 1925 into the very difficult country about the headwaters of the Paranatinga and the Xingu. No news had been received from him since the dispatch dated May 30 from Dead Horse Camp in 11° 43′ South and 54° 35′ West, and there was grave anxiety for the fate of his small party. A relief expedition, in the ordinary sense of the term, seemed to be impossible, for its objective was indeterminate. But a mission of exploration and inquiry in the region where he had disappeared offered at least the chance of learning his fate, and at best the possibility of succour, if he should be detained a prisoner of an Indian tribe, as was not impossible. Such an expedition, on a scale which seemed large for so inhospitable a country, was organized by Commander Dyott, a Fellow of the Society with much experience of travel in such difficult conditions, and after many difficulties and delays started north from Cuyaba in May last. A few written dispatches, and a wireless message or two, reached the North American Newspaper Alliance during August, of which the last was doubly disturbing. It reported that the Fawcett party had perished in 1925, and that the relief expedition were themselves in difficulties. The full text of this dispatch, courteously communicated to us by the North American Newspaper Alliance, was as follows :

East of the Kuluene River. August 18.

I am sorry to report that the Fawcett Expedition perished at the hands of hostile Indians during July 1925, five days after it crossed the Kuluene river, an affluent of the Xingu. We successfully followed Fawcett's trail although we were hampered by losing much food in the rapids. The Indians who went with Fawcett agreed to show us the remains of the three explorers in the jungle, but complications with another tribe prevented our going to the spot. Our position is critical. We have suffered much and our resources have dwindled. We cannot even afford time to send full details by wireless. We must descend the Xingu without delay, or we ourselves will be caught. We have had serious trouble with the Indians, and only avoided a clash by strategy. This message has cost us a great effort to send, but tell our friends that we are on the way out before it is too late. We hope to reach Para at the beginning of October.—DYOTT.

The preface to this message as communicated says that it was sent by Commander Dyott's wireless operator to Senhor Vasco Abren, who has an amateur station at Rio de Janeiro, and succeeded in getting an inquiry back to the expedition, whether there would be any further messages. The reply was: "This will be the last message by wireless, as we are compelled to drop the apparatus because of its unbearable load."

This message was sent out from New York on August 19, so there was no serious delay involved in a double relay *via* Pittsburg and Hollis, N.Y. Hence we may suppose that an undated message received in New York on August 17 was despatched on the 15th or 16th. It was a brief message to Mrs. Dyott: "Have had trouble with wireless. Don't feel any anxiety if you don't hear from me. Am very well. Am trying to follow as fast as possible Fawcett clue."

That explained why there had been no reports for a long time, but left much else uncertain. Were the Indians who went with Fawcett already of the party?

Had they already told their story of Fawcett's fate (the clue), and was Dyott on August 15 or 16 travelling with them to the scene of the tragedy they reported, to verify their story by examining the remains? Or did events develop so quickly that between the 16th and 18th he had met those Indians, had become involved with others less friendly, and was already after two days in a critical position? Did the "Indians who went with Fawcett" profess that they had been with him to the end, and were eye-witnesses, or had they only been with him at some time or other, but had heard from others what had happened? And was he justified in either case in giving full credence to their story, which it may have been much to their advantage to tell?

On the answers to these questions, for the time being unanswerable, depended our judgment, whether or no the fate of Colonel Fawcett and his two companions had been ascertained. It was a tantalizing outcome of so gallant an effort, and aggravated by grave anxiety for the safety of the would-be rescuers, whose adventures were but imperfectly told in the two written dispatches that had been received.

The first of these was from Bakairi Post dated June 10, published on August 30. The passages useful to our purpose are these:

Leaving Burity in a motor launch [?] we travelled to San Manoel river in twelve hours, covering open country of a most unattractive nature. . . . At San Manoel we found that most of the baggage had gone on ahead, so we lost no further time ourselves in advancing. We rode three miles and made camp on the banks of the San Manoel river, crossing over the next morning. . . . The bullocks started to buck and distribute our cargo on the water. Unfortunately our wireless was damaged, and so was one of the cameras. . . . Then came a long march over open country: little game and not very interesting. For three days this kept up. On reaching the Paranatinga river we found it too deep to ford, and we crowded the baggage into a canoe, making the animals swim. One day more and we made Bakairi Post. . . . The crossing of the Paranatinga was quite a task. Our pack train has increased until now we have seventy bullocks and twelve mules. The amount of cargo we have seems colossal, but it is all essential if we are to accomplish our mission.

Colonel Fawcett, whose rescue this expedition hopes to bring about, crossed this river further downstream and then came to Bakairi from the west. There has been a great deal of discussion regarding what direction Fawcett took after leaving here. We sent our scouts in advance to follow his route, and in consequence we have made the interesting discovery that Fawcett never went *via* the San Manoel, Paranatinga, or Tapajos rivers, which many had believed. In 1910, when Fawcett was here first, he made a trail to the Paranatinga, and then came back, unable to advance. In 1925 he followed this old route of his, not all the way, but up part of it. Then he swung around due east to the headwaters of several streams which go to make up the Xingu.

In 1920 Fawcett, riding with pack-horses, left Cuyaba on April 20 and arrived at Bakairi Post on May 15, about 140 miles in a straight line. Dyott took only five or six days from Burity to the Post, about 120 miles, but his baggage train had gone ahead, and he himself went by motor to the San Manoel, which is usually an alternative name for the Paranatinga, but on the 1/M map an affluent. The twelve hours' motoring covered perhaps 90 miles of the 120. From the crossing of the San Manoel to Bakairi Post took about

five days with the baggage train, and already he seemed to have been in touch with Indians who professed to know a great deal about Fawcett's movements.

The second letter was dated "In camp on the Kulisevu river, June 17," and seems to have arrived by the same mail as the first, being published on August 31.

The river on which we are now in camp is an affluent of the Xingu, and our position is approximately 54 degrees west, 13½ degrees south. How we got here is not much of a story. Good luck has followed our hunt, and we have picked up various clues to the missing Colonel Fawcett from wandering Indians. These clues have served us well. At Bakairi we engaged five Bakairi Indians of the semi-civilized kind to serve as guides and help us when we made contact with their less sophisticated brethren in the far-off jungles. With five more mouths to feed, we have had to increase our food supplies and extra bullock men have had to be provided also. We look like a young army on the move. . . . We have covered some seventy odd miles over broken country, crossing sizable rivers and many streams that gave us trouble. This region is completely vacant with the exception of Indians. The Bakairis are an agricultural people and live on bananas and mandioca, which they grow themselves. The Jayapos are a warlike tribe who hunt game and are continually on the move. We never know where they may turn up, and they are a source of terror to all the local people. . . .

We have kept a course of more or less seventy degrees east of north for the last five days. On the third day we reached a river to which the Indian scouts had followed Colonel Fawcett's trail. This was where Fawcett had camped on 29 May 1925 and lost his horse, hence he called this place Dead Horse Camp. From this point onward we saw marks of knives and occasionally axes on tree-trunks. But they seemed to be of two periods, one about three years old, and the others more recent, perhaps two years old or less. . . .

We reached the banks of this river, the Kulisevu, on the sixth day after leaving Bakairi Post. . . . Our bullock drivers hasten back to-morrow, having no wish to linger in this inhospitable land any longer than necessary. Our camp is in a dense belt of forest lining the banks of the river. The radio is up and just getting on the air. We hear many stations working in different parts of the globe. . . . We chat with a man in London, 5HS. He has just spoken, saying that he can hear our feeble chirp from the jungles of Brazil. . . . A few days back we heard the operator with the Macmillan Arctic Expedition. He was speaking to New York. He told his friend to wait a moment, as a couple of Eskimos had come on board and he wanted to go and look them over. . . . We have not seen much game so far: a few deer and that is all. Even fish have been scarce, and only in one river did we catch any.

Reference to the account of last February will show at once an important contradiction between that and this report of Commander Dyott. In his last letter to his wife, dated 29 May 1925, Colonel Fawcett begins: "Here we are at Dead Horse Camp, latitude 11° 43′ South, and longitude 54° 35′ West, the spot where my horse died in 1920." The discrepancy in date may be explained easily as a lapse of memory when Commander Dyott, who had all these last messages of Fawcett, was working under difficulties. But it is much more difficult to explain the gross discrepancy of position.

After some weeks of anxiety as to the fate of the relief expedition we were pleased to receive through the North American Newspaper Alliance the following copy of a dispatch sent by Commander Dyott on his arrival at Para.

It gives a very circumstantial account of the fate of the Fawcett party, but must, we suppose, be read always with reserve that no conclusive proof could be obtained of the Indian narrative. The report is as follows:

Para (Belem), Brazil, September 26.

We descended the Kulisevu River in twenty-six days in a canoe and reached the camp where Colonel Fawcett and his party abandoned the river and struck overland in an easterly direction. At that point I met the chief of the Anafuqua Indians, a man named Alloikue, who said that he with two men and two women had helped to carry Colonel Fawcett's baggage. After much bargaining I persuaded Alloikue to go with me, but I was unable to make him tell me the fate that had befallen Fawcett and his men.

I spent the night at the chief's house, and there I found several articles which had obviously belonged to Colonel Fawcett. These included clothes, a tin trunk, and also parts of instruments. On questioning the chief he told me that these things had been given to him by members of another tribe called the Galapalos, but I should very much doubt this.

The expedition followed Colonel Fawcett's trail for many days and found evidence that Fawcett had passed that way. After some hard going we reached a place called Maroca, inhabited by Galapalos Indians, and from these people I learnt that the other tribe, as they called it, meaning the Anafuqua Indians, were "no good at all." After I had established friendly relations by the usual means of presents, the Galapalos told me that Colonel Fawcett had been killed by Indians five days after passing east of the River Kuluene. Asked how they knew of this, they replied: "We followed the white expedition, and for four days we saw the smoke of their camp fire. On the fifth day there was no more smoke, and we knew that the white men had been killed by bad Indians." They added, "The Galapalos Indians are good. They don't kill people."

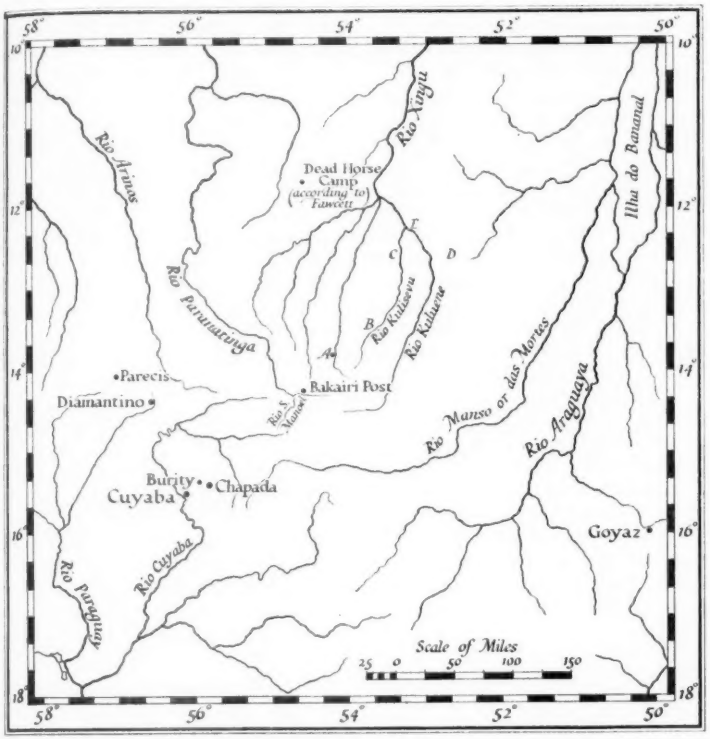
We continued our march to the Kuluene River and obtained further news from the Galapalos Indians. They told us that they had followed the tracks of Colonel Fawcett's party and had found where the members of the party had been killed in the jungle. String had been tied from one tree to another, and from this string hung yellow and black feathers as a sign not to follow beyond that point to the scene of the killing.

We confronted the chief Alloikue of the Anafuqua Indians with this information, and he then told us that the killing had been done by Suyas Indians, and that he himself had not gone beyond the Kuluene River. Alloikue continued to insist upon the peaceful character of his tribe. He said that the Anafuquas were good men. That is as it may be.

On reaching the Kuluene River Alloikue developed quite a knowledge of the place and took me some distance to the east, pointing out the direction in which Colonel Fawcett had gone and the ruined house where Colonel Fawcett had slept. Eventually he said he would not go any farther because he was afraid of hostile tribes, and he [? we] went back to the Kuluene River and descended it, joining my party where the Kulisevu and the Kuluene join.

On the way down the Xingu I tried to make Alloikue talk, but he demanded presents before he would give me any information, and I had no gifts to spare. Moreover, other Indians were coming with us and I had to keep some presents for them. I therefore told Alloikue that I would give a rifle to the man who would show me the place where the white men had been killed. He at once said that he would show me their bones, some of which he declared still remained.

I made a bargain with him to go up the river again in a few days to the spot where he declared the bones were lying, but soon afterwards we were sur-



SKETCH-MAP, BASED UPON THE 1/MILLION MAP OF THE BRAZILIAN ENGINEERS' SOCIETY, TO ILLUSTRATE COMMANDER DYOTT'S REPORTS

A is about the position assigned by Dyott to Fawcett's "Dead Horse Camp" two or three days before reaching the camp at B on the Kulisevu, and about halfway from Bakairi Post to B.

B is the camp on the Kulisevu given as about 13½° S., 54° W., the general direction of march for five out of six days from Bakairi Post being N. 76° E. B is plotted in the assigned latitude, but shifted east in longitude to the map position of the river. If the river had been shifted to the assigned longitude, B would have agreed worse with the compass bearing.

C is twenty-six days' journey by canoe down the Kulisevu, but above the junction with the Kuluene. It may well be nearer the junction than is shown.

D is somewhere about the point five days east of the Kuluene, at which Colonel Fawcett's party are reported killed.

E is the river junction where the Dyott expedition encamped on a sandbank, and whence they escaped down the Xingu.

All five positions are based on the incomplete indications of the narrative, and are published with reserve.—ED. *G.J.*

rounded by hundreds of Indians demanding axes, knives, and gifts of all sorts. They even threatened to help themselves if we were not sufficiently generous. The situation became critical. To divide our small party was unwise, yet we could not all go up the river again as some of our people were ill. I determined to go alone, that is to say, without any other white man, and everything was arranged for my departure. When the morning on which I was to start came, however, two camaradas (half-caste carriers) refused to accompany me. They told me how a young Indian of our party who spoke Portuguese had informed them that he had overheard Alloikue tell his companions that we would not get very far because he would kill me in the same way that he had killed Colonel Fawcett, and would then take everything that we possessed.

There seemed a ring of truth about this statement, so I decided to bluff Alloikue. I told him that I had made up my mind to take all my men up the river again, and that we would leave on the following day. Next morning I found that Alloikue had disappeared during the night, suspecting that I was plotting to kill him.

Every day more Indians arrived in camp asking for presents and refusing to take no for an answer. They threatened us with violence if we did not give them presents. Each hour saw more arrivals, both along the jungle tracks and in canoes which came full of armed warriors. It began to look as if there would be no escape for us and as if we were going to be butchered by the Indians, who became more and more aggressive, openly stealing our belongings.

That evening I called together a meeting of chiefs and told them that I would give each man an axe and a knife. This seemed to satisfy them, and they went back to their camps in the forest where their camp fires were lit. They left no guards where we were, and we found ourselves alone on a sandbank in the river where we had pitched our camp. We worked like ants until all our belongings had been loaded upon canoes, and we then slipped off noiselessly down the stream. We kept going steadily for two days before we really felt we were out of danger.

I feel sorry for the next expedition that goes into this region because of the fury of the Indians at our escape.

Commander Dyott must be warmly congratulated upon the issue of an expedition which seemed to have small chance of success. He has long experience of dealing with Indian tribes, and is doubtless as well equipped as any traveller to estimate the credence which should be given to their reports and to weigh the probability that self-interest might have led them to promise without justification what they believed the travellers wanted to discover. Fears which had been expressed that Commander Dyott might have hampered himself with too large a party and too extensive an equipment were to this extent justified, that he seems to have been compelled to sacrifice much of his gear in order to extricate his party from a very dangerous position. In the absence of any indication to the contrary, we may assume that the whole party came through safe, though it was reported in an earlier message that many of them were sick. In the accompanying sketch-map the route of the expedition has been laid down as far as can be from the meagre indications given in the dispatch. For greater precision, and especially for the elucidation of the curious discrepancy between the two positions given to Dead Horse Camp, we must await further news from Commander Dyott, to whom in the meanwhile a message of congratulation has been cabled. A. R. H.

11 October 1928.

THE CONFERENCE OF EMPIRE SURVEYORS

By A. GODWIN-AUSTEN

BETWEEN July 2 and 13, and immediately preceding the International Geographical Congress held at Cambridge, took place the first official Conference of Empire Surveyors. This Conference was a landmark in the development of Colonial Survey Departments, and a brief review of the position as regards Colonial Survey and the circumstances which have led up to this Conference will not be amiss. It may be said that practically all the boundaries of our Colonies have been surveyed and demarcated, such surveys generally being performed by Boundary Commissions officered by military surveyors, who carried out a system of triangulation along the boundaries, which provided the colony with an initial framework, and a collection of maps of the area dealt with. Colonies meanwhile had formed their own Survey Departments to assist in the interior development of their territories, making surveys in connection with existing and future town sites, mining, and timber concessions, land settlement, etc., practically the whole of the work of the Survey Department being done in connection with the Lands Office. Owing to economic considerations, the initial framework of triangulation was almost always lacking, and the work done consisted of scattered surveys, unconnected to each other or to any common framework. The only maps of the country as a whole were those compiled from Boundary Commission Surveys, local surveys as mentioned above, and route traverses provided by officials resident in the various administrative centres. As development proceeds demands for maps are created by mining, timber, land, and other interests, and topographical surveys rendered necessary, to enable persons interested to organize the schemes contemplated. In the Far East the development of natural wealth by civilization has so hastened the growth of some survey departments, that they are now completely equipped for all survey duties, geodetic, topographical, cartographic, and cadastral. In Africa rapid development of natural resources is calling for growth of survey, and before long all survey departments will be expected to produce the topographical maps essential to advanced industry and administration. Realizing the problems confronting us, we are now wondering how, with our inadequate staff and overfull programmes, we shall be able to tackle them successfully. These problems are common to all countries old and new, although the methods of survey may differ, owing to different physical and economic conditions. The various departments being scattered and far removed from centre of scientific thought, we find it difficult to keep in touch with modern developments and ideas. Also in the matter of liaison, we are often nearer our fellow worker in London or through London than we are as neighbours. Such then, generally speaking, was the situation when H.M. Colonial Office issued an invitation for a conference in London, and it is not surprising that the response was as representative as could be expected, considering the difficulty of making attendance fit in with normal leave conditions, etc. In all sixteen survey departments sent delegates, and representatives from the Admiralty, War Office, Colonial Office, the Ordnance Survey, Oxford and Cambridge Universities, and the Royal Geographical Society also attended. It is greatly to be deplored that no

delegates were able to come from Australia, Canada, New Zealand, and South Africa, and we can only hope to meet them and obtain the value of their experience at some future meeting. The programme had been fixed for us in advance.

Delegates met at the War Office, and after general introductions proceeded to the Colonial Office, where the Conference was officially opened by the Secretary of State for the Dominions and Colonies, who, in a very appropriate speech, referred to the importance of survey and mapping from the earliest times, and the means by which primitive races depicted details of the country in which they dwelt, also emphasizing the primary importance of maps for facilitating development in new countries.

The delegates were then entertained to luncheon at the Carlton Hotel, the Secretary of State for War occupying the Chair. In his speech he referred principally to the association of military surveyors with Colonial surveys particularly in connection with Boundary Commissions, pioneer work of this nature frequently becoming the basis of subsequent survey operations in the territory concerned. After luncheon the Conference visited the Geographical Section of the General Staff at the War Office, inspecting the Portable Time-Signal Receiver and Phasing Unit shown by the Marconi Company, the plotting from air photographs, map drawing, and reproduction.

The following day, July 3, was spent at the Royal Observatory, Greenwich, when under the direction of Sir Frank Dyson, delegates were shown the means by which standard time is determined and the instruments used in the past and the present, with the new installation of Shortt clocks. Delegates were relieved to hear from Sir Frank Dyson that the fears expressed by Capt. McCaw, that time signals sent out by various outside stations were so inaccurate as to introduce serious errors in determining longitude were not as real as was thought.

Luncheon was taken in the historical Octagon Room, with its wonderful view over the Royal Naval College and the Thames. A visit to the Naval Museum completed a most enjoyable day.

The morning of Wednesday July 4 was spent at the War Office, when papers were read on Surveying from Air Photographs, by Capt. Hotine, and on Reproduction, by Major Cheetham. Considerable interest was evinced by delegates in Capt. Hotine's paper, since the practical application of Air Photography to Survey opens up tremendous possibilities in areas hitherto unmapped. The Director of Surveys for Northern Rhodesia gave an account of the methods adopted in that country, in work now being undertaken in connection with a survey of part of the Rhodesia–Congo Border and also of a long stretch of the Zambezi river. The most important factor, cost, was discussed and data exchanged. The initial cost of transporting the aeroplanes and personnel to the scene of operations appeared to be one of the most important considerations.

During the afternoon delegates visited the National Physical Laboratory at Teddington, where, under the guidance of Sir Joseph Petavel, they were shown the means by which instruments and standards are tested. After the inspection, delegates were entertained to tea in the beautiful garden adjoining the Director's residence overlooking Bushey Park.

Thursday July 5 was devoted to hydrographic survey conducted by the Admiralty in the preparation of Charts. Rear-Admiral Douglas gave a lecture on the subject, with special reference to echo sounding. Instrument development was then dealt with by Capt. Hill, R.N., the Tavistock Theodolite being described and shown and the advantages of a new 45° Prismatic Astrolabe over the 60° one demonstrated. A visit to the Admiralty Chart Establishment at Cricklewood was made during the afternoon. The visitors were particularly impressed by the high standard of craftsmanship attained by the copper-plate engravers, and the methods of revising copper plates and combining copper-plate engraving with photographic methods of reproduction proved most interesting.

During the morning of July 6 a visit was paid to the Geological Museum, where an address was given by Mr. J. Allen How on the work of the Geological Survey of Great Britain, after which delegates inspected the collection of Geological Maps. The method by which the wide range of colours necessary for these maps was obtained with only five printings was explained.

The afternoon was spent at the Royal Geographical Society's house, delegates being shown the Prismatic Astrolabe attachment and other instruments by Mr. Reeves. The many historical relics in the Society's Museum were described, important early books and atlases were examined, and delegates subsequently entertained to tea.

The morning of Saturday July 7 was spent at the War Office, when a paper was read by Capt. G. T. McCaw on Astronomical Azimuths, particular attention being paid to the question as to how far observed azimuths should control triangulation. The subject had been thoroughly investigated by Capt. McCaw and his conclusions were endorsed. Discussions followed on (*a*) A proper exchange of Empire Cartographic Material; and (*b*) A proposed Empire Survey Journal. In respect of (*a*) delegates agreed to an exchange of various types of maps in use in their respective spheres. In respect of (*b*) delegates agreed that the proposed Journal would be extremely useful and instructive, and decided that its production should be undertaken. The questions of ways and means, publication and control, were discussed and a Committee appointed to put the deliberations into definite shape. It was decided that the proceedings of the Empire Surveyors' Conference should comprise the first copy of the Journal.

On Monday July 9 members met at the Ordnance Survey Office at Southampton, and papers were read on the History and work of the Ordnance Survey, by Col.-Commt. E. M. Jack; The Problem of Revision, by Lieut.-Col. M. N. MacLeod; The Application of Air Photographs to O.S. Revision, by Major D. A. Hutchison.

A discussion followed on Courses for Colonial Survey Probationers and a few suggestions were put forward in respect of the Syllabus submitted. The afternoon was spent viewing demonstrations of Ordnance Survey Revision Methods in the field.

July 10 was spent in visiting the various branches of the Ordnance Survey Office. The entire process of producing a map, from the triangulation and field sheets, through the drawing, printing and binding, to the disposal of the finished article was seen, and provided a very full day.

On the following day papers were read on The new levelling of England, by Lieut. A. W. Heap; Lettering on Maps, by Capt. J. G. Withycombe; Geodesy of the British Isles, Col. Sir Charles Close. Each subject had been so carefully studied by the author as to leave no room for criticism. The members of the Conference were subsequently photographed and entertained to luncheon in the Library.

During the morning of July 12 a visit was paid to the Science Museum, where an address was given by Sir Henry Lyons, delegates subsequently inspecting the collection of early maps and ancient surveying instruments. Representatives of the leading firms of instrument makers demonstrated the most modern types of surveying instruments and the instrument used by the Admiralty for echo sounding was also shown. The Tavistock Pattern Theodolite attracted much attention as a promising effort of British makers to secure the advantages in accuracy and lightness achieved by Wild and Zeiss. A representative collection of modern maps produced by various Colonial Survey Departments was inspected with much interest.

The afternoon was spent at the War Office, where a paper was read by Col. H. St. J. Winterbotham on "Boundaries." The subject was thoroughly dealt with both from the diplomatic and technical standpoints. Emphasis was laid on the difficulties experienced by the surveyor in demarcating a boundary, the delimitation of which had already been made without full knowledge of the physical characteristics of the country. Subsequent discussion tended to show that the Surveyor should be allowed considerable discretion in demarcating a boundary.

A paper on "Colonial Survey Reports" was read by Capt. G. T. McCaw. The object aimed at was uniformity. The discussion which followed revealed the fact that the Annual Departmental Report of a Colonial Survey Dept. is intended to show only the economic result achieved during the period covered and matters of purely technical interest are not required. It would appear therefore that a separate Report would be necessary to cover the requirements as laid down in the paper read, and provided that the clerical staff necessary for producing such an exhaustive document was forthcoming, a great deal of information useful to authorities at home could be produced. Many delegates reported that they were making careful study of the matter of unit costs of surveys; but it was agreed that owing to the wide difference of conditions in various colonies, the data arrived at would probably only be valuable for the colony to which it referred, and could not be used as indicative of the cost of similar operations elsewhere.

Friday July 13 was spent at the War Office, when a paper prepared by Mr. J. Clendinning of the Gold Coast Survey was read by Mr. Mindham. This paper showed how the problem of surveying a densely wooded country by precise traverse was dealt with and the method adopted for the computation of co-ordinates for the projection used. A discussion was opened by Col. H. St. J. L. Winterbotham on the Surveys of Africa and the desirability of completing the Survey of the Arc of the 30th Meridian. Discrepancies between astronomical and geodetic azimuths are known to exist north of the Limpopo river, so that to complete the arc satisfactorily investigation in S. Rhodesia would be necessary. Delegates agreed that the completion of the

arc was most desirable from a scientific standpoint, since it could eventually be connected with the great Arc of the Meridian from the mouth of the Danube to the North Cape, thereby completing the longest arc of meridian that can be measured on the surface of the Earth. Delegates from the colonies through which the connecting links would pass expressed the opinion that the staffs at their disposal would be inadequate to undertake the necessary work, and it was agreed that the work should be undertaken by the Imperial authorities acting in liaison with Colonial Survey Departments. They also expressed the opinion that such work would be invaluable to them as a basis on which to build up local systems.

The Conference closed on the evening of the 13th, when delegates were entertained to dinner at Lancaster House. The Secretary of State for the Dominions and Colonies was in the Chair, and in reviewing the work of the Conference expressed the hope that the Conference now ended would prove to be the first of a series of such Conferences, which helped so much to further the activities of Colonial Survey Departments. Mr. Lowinger in replying thanked the Chairman for the cordial reception that had been accorded to the Conference, and the assistance rendered by the Government in enabling it to complete its programme so successfully.

The visits included in our programme constituted in a way the most valuable part of it; bringing us as they did in direct touch with those whose activities so largely affect our work, and the details of which many of us previously knew nothing. It is also very gratifying to realize that they have our interests at heart, and are truly anxious to help us over our difficulties. I should like here to speak for my colleagues and to acknowledge, however inadequately, the kindly reception and charming hospitality which we met with wherever we went.

Apart from the benefits derived from inspections and discussions, it was found that much interest and mutual advantage was derived from individual exchange of ideas and methods. The scheduled programme did not leave a minute of superfluous time and one would frequently have liked to have devoted more time to some particular item than the restricted period available permitted.

One criticism I would like to offer, namely, that I think that a discussion on our cadastral methods would have been most useful. Cadastral problems will always form a large part of our work and an interchange of views would be appreciated by all.

By this Conference we have, it is hoped, laid the foundations for co-operation in our work, and for recording the experience of a body of surveyors who have to work under all conditions of climate and topography. By means of a conference such as this we gain an experience and collect a literature invaluable to ourselves, and one impossible to obtain elsewhere.

As regards the arrangements made for the Conference by the Colonial Survey Committee, it is sufficient to say that there was no hitch of any kind throughout. We were housed by the War Office, welcomed by the Admiralty and Ordnance Survey, and entertained royally. Thanks to the efforts of those who were responsible for it, the Conference was a conspicuous success, and it would be both unbecoming and invidious to say more.

THE LUPATA GORGE ON THE LOWER ZAMBEZI

F. DIXEY, D.SC., F.G.S.

DURING May of the present year the writer had the opportunity of making a geological reconnaissance of the country lying north of the Zambezi in the neighbourhood of the Lupata Gorge, and the following observations made in the course of this journey may be of interest.* A brief description of the gorge and of the course of the river below it was given in 1915 by E. O. Teale and R. C. Wilson,† and in 1922 F. P. Mennell‡ showed that the main series of alkaline lavas comprising the Lupata Hills was preceded first by Karroo lavas, and then by a great sheet of rhyolite interbedded with a series of pebbly sandstones; this rhyolite was described as capping the magnificent scarp seen at the entrance to the gorge.

The gorge owes its existence to the occurrence of the thick series of lavas that runs across the course of the river, and into which, as a result of long-continued uplift in this region, the Zambezi has slowly incised its channel. The outcrop of the lavas, although running north and south in the neighbourhood of the river, ultimately swings around towards the east and gradually dies out; it thus forms a broad crescent-shaped area within which the successive flows dip gently towards the centre, whereas on the outer convex margin their worn edges give rise to lines of bold cliffs that stand hundreds of feet above the surrounding country. The form of the uplands is thus determined mainly by the inward dip of the larger and more resistant flows, but in the neighbourhood of the Zambezi the country is much dissected, and elsewhere a few peaks, marking the remnants of the later flows, stand well above the general level. From any one of these peaks the vegetation can be seen to reflect the structure of the area, for in general the backs of the flows form grassy uplands, whereas their edges appear either as rocky cliffs or as wooded scarps. As the tributary valleys approach the main gorge they tend to incise their beds more and more below the level of the adjacent country.

In the beds of the larger rivers that cross the whole volcanic outcrop, such as the Minjobva, or in others that originate within it, such as the Nkomadzi, water may be found at all seasons, and in the lower part of the Nkomadzi, for example, the soil is very fertile. But in general the country is extremely dry throughout the greater part of the year, and the thin gravelly soil scarcely disguises the rocky nature of the ground; the uplands are accordingly very sparsely inhabited, and tracks across them are few in number and of the roughest character. Nevertheless, the hill slopes overlooking the river gorges and the surrounding plains are frequently the haunt of many species of big game, including particularly the lion, rhinoceros, and buffalo.

Above the gorge the Zambezi traverses broad sparsely wooded lowlands diversified by numerous low hills of Karroo sandstone and then of basalt. The river itself is of great width; on its banks stand many villages, and a river steamer can occasionally be seen following its devious course.

*I wish to express my indebtedness to the Portuguese Administration for kind permission to undertake this reconnaissance.—F. D.

†*G.J.*, 1915, p. 31; see also E. O. Teale and W. Campbell Smith, *Geol. Mag.*, 1923, p. 227.

‡*Geol. Mag.*, 1922, p. 169.

The Zambezi above the Lupata gorge

Looking S.W. across entrance to Lupata gorge along scarp of rhyolite flow

Lupata rhyolite scarp overlooking Zambezi plain above the gorge

Head of the Lupata gorge from Sungo

Cliffs of columnar rhyolite on right bank of the Lupata gorge near entrance

Camp at Bandar at exit of gorge: profile of lava-flow beyond

But on approaching the gorge the river suddenly contracts to a small fraction of its normal width and hurries on between high rocky walls; the scenery here is perhaps more striking than at any other point on the Lower Zambezi, and it is due principally to the presence of the fine sheet of columnar rhyolite that initiated the Lupata volcanic episode, and to the contrast of the light grey edges of this flow with the dark wooded escarpments of the alkaline lavas beyond. On the northern side of the river the great transverse cliff continues undiminished in height for rather more than a mile, and then gradually passes beneath the later lavas; on the south it swings away to the south-west and continues for many miles. At the entrance to the gorge the rhyolite cliffs rise to a height of 600 feet above the river on either side; the flow itself is about 260 feet thick, and it rests upon several hundred feet of pebbly sandstones that form the wooded slope immediately underlying the vertical cliff. A little beyond the entrance to the gorge the base of the rhyolite is carried down to river-level by the dip of the beds, and there the cliffs on either hand rise sheer above the water's edge to a height of several hundred feet. Then for a short distance the sides of the gorge are low as they traverse the outcrop of a second series of pebbly sandstones resting on the rhyolite, but they rise again to yet greater height as they cut across the lower flows of the main Lupata volcanic series; the lava-flows soon attain a height of about 1000 feet above the river, but as Bandar is approached 9 or 10 miles lower down they are gradually reduced to a height of only a few hundred feet; the hills then fall away on either hand and the narrow rock banks give place to broad and fertile alluvial plains. Below the gorge the river resumes its normal breadth and meandering course, and as far as Sinjal the rising ground to the east along the Anglo–Portuguese border is occupied principally by basalts and sandstones of Karroo age. South of Sinjal the pebbly sandstones of the Lupata area and afterwards the associated rhyolitic lavas reappear and form high ridges overlooking the left bank of the river to within a short distance of Mutarara; on the opposite bank near Sena there are low plains of pebbly sandstone out of which rise a number of conical hills due to small pipe-like intrusions that mark the sites of old volcanoes. Beyond these the river pursues an uninterrupted course over broad alluvial plains that eventually give way to the great Zambezi delta.

THE TANGO (JAPAN) EARTHQUAKE OF 7 MARCH 1927

CHARLES DAVISON, SC.D., F.G.S.

SINCE the great earthquake of 1923 the Empire of Japan has been visited by two destructive earthquakes—the Tajima earthquake of 23 May 1925, in which 325 persons lost their lives, and the much stronger Tango earthquake of 7 March 1927. Both occurred near the Japan Sea coast of the main island, to the north of Kyoto and Osaka. The epicentre of the Tajima earthquake lay in lat. 35° 38′.7 N., long. 134° 50′.5 E.; that of the Tango earthquake about 11 miles to the east in lat. 35° 39′ N., long. 135° 1′ E. The district is one that is almost immune from earthquakes. Koto, in his admirable study of the earthquake, gives a list of about a dozen shocks felt in the province during the Christian era. Three of these, in 675, 701, and 1694, may perhaps vie with the recent earthquake in strength.

According to the latest estimate (Imamura) 3017 persons were killed, the great majority in the four central counties of Yosa, Naka, Takano, and Kumano; 10,633 houses collapsed and 9821 half collapsed, 4961 were burned and 115 half burned. Of the total population in the four counties, $2\frac{1}{4}$ per cent. lost their lives, and of the houses existing before the earthquake $41\frac{1}{2}$ per cent. collapsed and $18\frac{3}{4}$ per cent. were burned. In Mineyama, the principal town of the district, about 80 per cent. of the houses were destroyed by the shock and most of the rest were burned. The villages of Gō and Yamada lost 90 per cent. of their houses. In no place does the loss of life approach the proportions so prevalent in some Italian earthquakes, the highest percentages reached being 24·5 at Mineyama and 27·9 in the village of Yosiwara.

The disturbed area is shown in Fig. 1, the dotted lines being the isoseismals drawn by Watanabe and Sato. Within the isoseismal 6, the shock was violent, but the area included is not more than 4 square miles. The isoseismal 4 bounds the zone in which the shock was strong; it contains 21,600 square miles. Between the isoseismals 4 and 2, embracing 36,900 square miles, the shock was weak. Thus, the total land area shaken was 58,500 square miles. Taking, however, the dimensions of the disturbed area as given by Watanabe and Sato, namely, 370 miles by 310 miles, it follows that the whole disturbed area would be about 90,000 square miles, or less than that of the Hereford earthquake of 1896. Koto has also drawn a series of five isoseismal lines in the central district only. They represent different percentages of crushed houses, and it is worthy of notice that all of them, and especially that of 80 per cent., cling to the remarkable faults described below.

The courses of these faults, as traced by Yamasaki and Tada, are shown in Fig. 2. Both of them were formed by movements along old faults, the Gō-mura being a transverse, and the Yamada a strike, fault. Within a mile on either side of each fault, the intensity of the shock was as high as one-half or two-fifths of gravity, and about 90 per cent. of the houses were destroyed. The more important, the Gō-mura, fault, starts from the coast of the Japan Sea, and, according to Koto, it can be traced running in a general south-south-easterly direction for a distance of 60 miles, as far as Osaka. In the epicentral area of the earthquake, it occupies the south-west side of a remarkable

rift-valley that crosses the neck of the Oku–Tango peninsula in the direction S. 30° E. During the recent earthquake the ground was displaced along this fault over a length of 11 miles. The fault here is not a continuous rift, but a series of five nearly parallel faults, each lying slightly to the east of the one north of it. Throughout the whole course of this fault, with two exceptions, the crust on the west side with respect to the other is elevated and is shifted to the south. The amount of displacement varies considerably, the greatest vertical rise being 2 feet 7 inches, and the greatest horizontal shift 9 feet 2 inches.

The appearance of the fault varies as it cuts across alluvial plains, river-terraces, or hills. In flat mountain valleys it forms generally a very distinct fault-scarp; in mulberry fields it looks like a large mole-track; in soft muddy rice-fields there may be merely a gentle warping of the ground. Many photo-

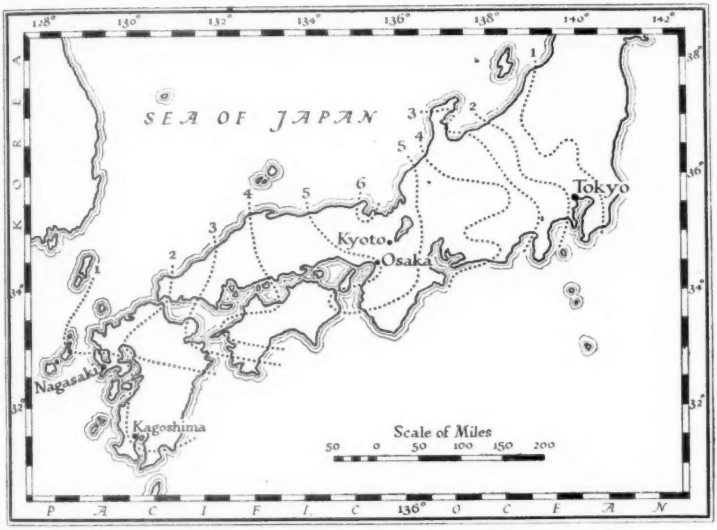


Fig. 1. The disturbed area of the Tango earthquakes

graphs of these various aspects of the rift are reproduced in the memoirs by Imamura, Koto, Watanabe and Sato, and Yamasaki and Tada.

The Gō-mura fault, according to Tada, is a reversed fault inclined, where it crosses mountain spurs and valleys, at angles of from 60° to 80° to the south-west. A similar estimate, of 70° to the south-west, is made by Imamura from the depths and positions of after-shock centres, which usually lie on the south-west side of the fault.

The elevation of the land on the west side of this fault was continued as far as the sea-coast, for a permanent upheaval, amounting in one place to 2 feet $7\frac{1}{2}$ inches, occurred along the coast from the Gō-mura fault to Tuiyama Cove, a distance of 10 or 12 miles.

The second fault, the Yamada fault, follows an old fault-scarp on the south-

west side of the Oku–Tango peninsula. It has been traced for a distance of $4\frac{1}{2}$ miles in the direction N. 55° E., the land on the north-west side being relatively elevated, in one place, by as much as 2 feet 3 inches, and shifted to the north-east by as much as 2 feet 7 inches. The fault passes through the village of Yamada, its movement crushing all houses and cottages into pieces. From the distribution of the after-shock centres, Imamura estimates that the fault-surface is inclined to the north-west at an angle of 75°.

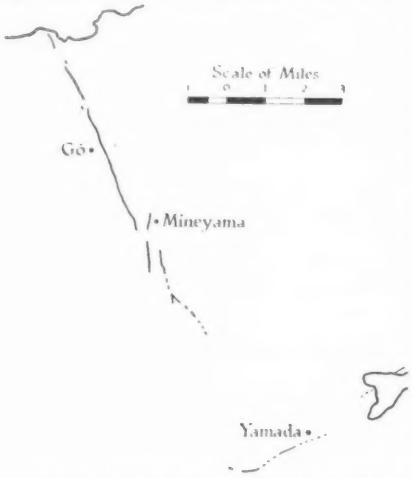


Fig. 2. Gō-mura and Yamada Faults

The precise nature of the displacements was revealed soon afterwards by new surveys in the central district. The Land Survey Department revised the triangulation and the series of levellings in May–June, again in August–September, and a third time in October–November, and the results were compared with those of the first survey made in 1884–88. About the same time the Hydrographic Office made an extensive survey of the sea-bed to the north of the central area during May–August. The previous one dates from 1892.

The surveys on land showed at once that, as in the San Francisco earthquakes of 1906, the crust-blocks on both sides of the faults had moved and in opposite directions. Imamura and Kishinouye have compared the results of the second and original surveys. Selecting stations on or near the straight line drawn at right angles to the Gō-mura fault through the point of greatest relative shift (9 feet 2 inches), they plotted the displacements and obtained the curves in Fig. 3, curves which closely resemble those obtained after the San Francisco earthquake. Producing them both ways, we see that the horizontal displacements nearly vanish at about 20 miles from the fault on either side, and that the total relative displacement along the fault agrees roughly with that given above. The analysis of the surveys by Yamasaki and Tada leads to one very interesting result, namely, that the movements did not cease with the great displacement of the earthquake. The first survey showed that the block on the west side of the Gō-mura fault had moved in general to the south-south-east with a maximum shift of 5 feet. Between the first and second surveys there was a displacement of as much as 1 foot 1 inch, but towards the north, or nearly in the opposite direction to the first movement. In the next interval this block had moved 2 feet 11 inches, once more to the south. On the other hand, the first and second surveys showed that the block on the east side of the same fault had moved as much as 3 feet 6 inches towards the north; while the third brought to light an opposite shift of 1 foot 1 inch. The second

survey, again, showed that the block on the south-east side of the Yamada fault had moved 1 foot 4 inches in a nearly northerly direction, while the third revealed a shift of 5 inches towards the south-west.

Similar results follow from the re-levelling of the district. The first line of levels crosses the area roughly in an easterly direction. The bench-marks nearest the Gō-mura fault show a rise of 1 foot on the west side, followed by a depression of 1 foot 5 inches on the east side. Similarly, from those nearest the Yamada fault, we have a rise of 2 feet 7 inches on the north-west side, changing to a depression of 1 foot 2 inches on the south-east side. By the time the second line was made, the vertical displacement had slightly increased, by $\frac{1}{5}$ inch at the Gō-mura fault and $\frac{1}{10}$ inch at the Yamada fault.

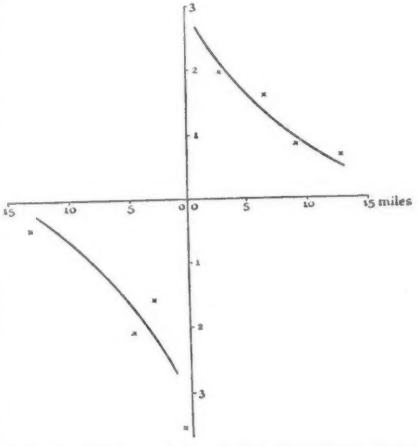


Fig. 3. Displacement of ground near Gō-mura fault: vertical units are feet

A comparison of the two series of soundings made in 1892 and 1927 shows none of the remarkable distortions that occurred in Sagami Bay in 1923, but the analysis of the observations by Terada and Higasi gives some interesting results. For instance, the vertical displacements along the Gō-mura fault are continued to a considerable distance beneath the sea and are greater in amount, an elevation of $1\frac{1}{2}$ feet on the west side changing to a depression of more than 13 feet on the east side. About a mile or two from the shore the whole coast is bordered by a zone of depression of more than 12 feet, while still farther out there is a broad zone of elevation. And, lastly, the north-east side of the Oku–Tango peninsula has undergone a general upheaval, evidently a continuation of previous movements in the same direction that have given rise to coastal terraces.

Within four or five days after the earthquake three seismographs were established in or near the epicentral area, two of them to the east and one to the west of the Gō-mura fault. A clinograph was also installed near the Yamada fault in order to measure variations in the inclination of the ground, and, some weeks later, another near the Gō-mura fault. After the third day the after-shocks rapidly declined in frequency, but the total number recorded by the end of the month amounted to 899. The seismographic records revealed two distinct types of after-shocks. In one, the initial phase was small, the shocks were connected with the Gō-mura fault, the epicentres as a rule lay to the west of it, and the depths of their foci (as determined by the duration of the preliminary tremor) were considerable, in some cases as much as $12\frac{1}{2}$ miles. In the other, the initial phase was comparatively large, the epicentres were on or close to the Yamada fault, and the foci were all

shallow, the deepest being not more than 5 miles from the surface. Equally interesting were the records of the clinographs. Besides the usual temperature variations every day, certain abrupt changes of inclination were registered, each of which occurred a few hours before one of the stronger after-shocks.

At the time of the earthquake there was no seismograph at work close to the Tango province, and, in consequence, we have no knowledge of the depths of the main parts of the foci in the principal earthquake. Possibly they were not very different from those of their respective after-shocks, for the record of the first great movement was not unlike the records of after-shocks connected with the Gō-mura fault, while that of the second resembled those of the Yamada fault after-shocks. There can be little doubt, however, as to the sequence of events. According to Imamura and Nasu, the stresses from north-west to south-east that affect the whole of Japan had been growing for years in the Tango area. By these stresses the crust-block on the west side of the Gō-mura fault was at last forced to rise very slowly. This strained condition lasted for a few hours, and then, all resistance being overcome, the western block suddenly sprang upwards and to the south-south-east, while at the same time the eastern block rebounded in the opposite direction. A sudden change was thus introduced in the stresses to which the crust-block on the north-west side of the Yamada fault was subjected, and, very rapidly, in its turn this block was suddenly elevated and thrust towards the north-east, the two movements together forming a great double, not a twin, earthquake. In both, however, the crust-blocks overpassed the positions of equilibrium, and for weeks afterwards, in settling back towards stability, minute slips here and there along the two faults gave rise to the numerous after-shocks that followed.

This paper is a summary of a large number of memoirs, of which the following are the most important:

1. Imamura, A. "On the destructive Tango earthquake of March 7, 1927." *Earthq. Res. Inst. Bull.*, vol. 4, 1928, pp. 179–202, pls. 34–49.

2. Imamura, A., and N. Nasu. "On the destructive Tango earthquake of March 7, 1927: a stereometric study of the seismic origin." *Tokyo Imp. Acad. Proc.*, vol. 3, 1927, pp. 227–231.

3. Ishimoto, M. "Observations sur les variations de l'inclinaison de la surface terrestre à Miyadu-mati and Kawabé-mura après le grand tremblement de terre de Tango." *Earthq. Res. Inst. Bull.*, vol. 4, 1928, pp. 203–222, pls. 50, 51.

4. Koto, B. "The intersecting twin earthquake of Tango hinterland in 1927." *Tokyo Fac. Sci. Jl.*, vol. 2, 1928, pp. 265–329, pls. 53–65.

5. Omura, H. "Horizontal displacements of the primary and secondary triangulation points, observed after the earthquake of March 7, 1927, in Tango districts." *Earthq. Res. Inst. Bull.*, vol. 4, 1928, p. 223, pl. 52.

6. Omura, H. "Comparison of the results of the first and second precise levellings in the region disturbed by the Tango earthquake." *Earthq. Res. Inst. Bull.*, vol. 4, 1928, p. 225, pl. 53.

7. Taniguchi, T. "Damages of buildings in the province of Tango due to a destructive earthquake." *Earthq. Res. Inst. Bull.*, vol. 3, 1927, pp. 133–162, 15 pls.

8. Terada, T., and S. Higasi. "Vertical displacements of sea bed off the coast of the Tango earthquake district." *Tokyo Imp. Acad. Proc.*, vol. 4, 1928, pp. 296–299.

9. Tsuya, H. "On the geological structure of the Oku-Tango Peninsula." *Earthq. Res. Inst. Bull.*, vol. 4, 1928, pp. 139–158, pl. 16.

10. Watanabe, K., and H. Sato. 'The Tango earthquake of 1927.' Japan Geol. Surv., Rep. No. 100, 1928, 126 pp., 11 pls.

11. Yamasaki, N., and F. Tada. "The faults of the Tango earthquake." *Tokyo Imp. Acad. Proc.*, vol. 3, 1917, pp. 223–226.

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THE COMMISSION ON PLIOCENE AND PLEISTOCENE TERRACES AT CAMBRIDGE

ALTHOUGH this commission was appointed by the Executive Committee of the International Geographical Union more than three years ago, nearly a year elapsed before its personnel was settled, and in the remaining two years no less than three of its members died. Of the survivors and of those appointed to replace the casualties five met for the first time at the Cambridge Congress in July of this year.

In the circumstances the preparation of a considered report before the meeting was impossible, but a First Report was published to form a basis for discussion and to set the mechanism of the commission in motion. This consisted of about twenty original communications and résumés, confined almost entirely to the coasts and rivers of the Mediterranean and of Western Europe in accordance with the limitations expressly stated at the appointment of the commission.

From the Report, and its discussion at Cambridge, a classification of some importance emerges. This makes it plain that the area so far considered may be divided into three parts:

1. *The mountain-building and volcanic zone* of the Mediterranean, *i.e.* from Italy to Greece, and probably to Asia Minor. Here strong vertical movements, tilting, and fractures (often quite localized) have destroyed, or prevented the establishment of, the regular conditions we find in the next zone.

2. The "*eustatic*" zone of the Mediterranean ("eustatic" being used purely as a convenient term without pre-judging the observations as evidence of land movement *en masse* or of change of sea-level). Excepting the region noted in (1) above, the zone probably comprises the whole of the Mediterranean seaboard and the rivers debouching into it, and it has been shown to extend beyond the Straits of Gibraltar along the Atlantic coasts of Spain and Western France, where it adjoins the third zone.

(3) The *isostatic* region is clearly enough marked in the northern part of the British Isles, the oscillations of which may be compared with those of Scandinavia. The southern part of the British Isles may be considered to play an intermediate part between the "eustatic" region to the south and the eustatic area to the north.

Such a classification is fairly obvious, but if attention be paid to it good should result, and its emphasis should prevent some of the wilder generalizations which occasionally find their way into print.

If the commission succeeds in driving home the essential differences of three such zones as are described above, its preliminary efforts will not have been wasted. Careful work and detailed research within this littoral and its rivers is now more important than ever; new work can be placed at once in the zone of

that type of movement to which it pertains. Above all we need faithful and unbiased observations and recording of facts and the elimination of scientific fiction. Even if we have gained a little it would be better to assume that we know nothing.

But the Commission has now been set the task of extending its activities beyond these confines. The new phase of its work must start as the first, by a statement of facts perhaps well known and accepted in certain regions, with a reconnaissance of the ground between those oases in a desert of uncertainty and of unrecorded fact.

Another of the activities of the Commission has been to set forth certain suggestions for the guidance of authors. This was first attempted in a brief circular issued two years ago and in the introduction to the First Report, but at the meeting in Cambridge it was taken up by the five members of the Commission present and fuller and more adequate recommendations were set forth. These seek to enforce uniform treatment, the use of suitable datum levels for recording vertical measurements, adequate references to bibliography, and so on; they will be published in a Second Report now envisaged.

The liveliness of the two public meetings of the Commission at Cambridge encouraged a good attendance of members of the Congress. At the first meeting the prosaic calm of an international gathering of scientists was ruffled by a breeze which concluded the programme, though small groups continued the discussion until the arrival of the caretaker. The second session was intended for the presentation of the report of the Commission to the Congress and for the continuance of learned discussion. The report was duly accepted, but after the meeting had run its allotted span and most of the audience had left to attend an important lecture, once more the air resounded with earnest discussion of differing views, expressed in as many languages. Subsequent inquiry elicited the fact that the Commission really had the hearty support of the meeting for its new "instructions to authors" which had just been read.

The discussions on the scientific aspects of the question were, in truth, intimately associated with the question of the composition of the Commission, a matter which was finally settled by the supreme authority—the Executive Committee of the Union. The anxiety of the representatives of the different nations to nominate members to the Commission may be looked upon as a measure of their interest in its labours and their desire to further them.

We hope that the many men of science who have studied the question will assist in this international endeavour to search out truth and order among terraces.

K. S. SANDFORD.

THE PANJAB: A REVIEW

THE LAND OF THE FIVE RIVERS: An economic history of the Punjab from the earliest times to 1890. By HUGH KENNEDY TREVASKIS, I.C.S. *Oxford: University Press* 1928. 8×5 *inches*; xx+372 *pages; maps and diagrams.* 15*s*

IT is difficult to review a work like this, which is in effect a digest of the latest authorities on the great race movements which have formed the present racial distribution in Southern and Western Asia and all Europe, of the growth and spread of religions, of the genesis of customs and laws, and of the gradual development of administrative and financial systems. Mr. Trevaskis' bibliography is an index of his industry and widespread reading, and, as he says himself, his work represents the thoughts and theories formed by him during 20 years in India. All of this is compressed into some 380 pages from preface and introduction to index. The work only carries us up to 1890, which he thinks marks the end of a period of quiescence rather than of great deeds in the history of the Administration of the Panjab, his land of five rivers, and the kernel about which he has accumulated this mass of information, and he promises a second volume dealing with the brighter and more active new era after that year. It is possible to question his selection of the date, as according to his own showing the revenue system of the Province had after long and acute discussions been remodelled and reformed before that date and steps taken to secure the interests of the actual cultivators. In fact, the first Panjab Tenancy Act, which established the great principle of fixity of tenure at a fair rent and which, according to the late Lord Morley, gave Mr. Gladstone his main ideas on the subject of Irish Land Reform, was passed as far back as 1868. The Acts regulating the modern system of administration of the Land Revenue, Forests, District Boards and Municipalities were all passed in the 'eighties, and they have only required minor amendments and no great revisions since.

It is also hardly the case that the great irrigation schemes which have made the Panjab what it is all date subsequent to 1890. Leaving out of sight the remodelling of Feroz Shah Tughlak's canal to Hissar as the Western Jumna canal, and the re-creation of Ali Mardan Khan's cut for supplying Lahore as the Bari Doab Canal (both of which were in full operation in the 'seventies), the great Sirhind Canal, still one of the largest in the Punjab, was started in the same period and opened in about 1884.

The Swat River Canal in the Peshawar District was also started in 1880 and opened in 1885, so also the Sidhnai Canal from the Ravi in Multan, which was the first serious attempt at State colonization of the southern Punjab wastes. The old-established network of inundation as opposed to perennial canals was also, of course, in full flow, and the great Lower Chenab Canal had been surveyed and resurveyed and was under construction for some time before 1890.

From very early ages irrigation has been a necessity of cultivation in the Panjab with its generally scanty rainfall and intense summer heat, and canals existed before historic times. The climate, too, has not apparently changed much. A Buddhist shrine in the foothills north of Peshawar was, as masonry remains show, dependent for its water supply on the same small spring that now exists, and that must have been built 2000 years ago. As we have found in Iraq, canal banks in a country of light rainfall are wonderfully permanent, and such canals existed probably before historical times parallel to but above the Swat Canal in Peshawar and parallel to the great Lower Chenab Canal. The latter, as the width of the old channel indicates, was a very great work. It was probably due to these canals that the plain of Yusafzai in Peshawar was studded with old villages, and that Sangla and other considerable cities existed in the waste of the Rechna Doab. Whether the destruction of the canals was due to the cutting

down of the intersecting streams, which made it impossible to carry the canal across them by banks, or to the numerous raids and invasions to which these tracts were liable, it is now impossible to say, but probably both causes operated. Certainly to the last was due the throwing waste of the heavily irrigated tract in Peshawar between the Swat and Kabul rivers, which lies very low, and is intersected by cuts. This in a few years of want of settled government would soon relapse into swamp, which would explain Baber's rhinoceros hunts. These circumstances must be remembered in dealing with the alleged gradual desiccation of the Panjab, though no doubt the destruction of forests in the lower foothills and in the Siwaliks must have caused damage. Happily this has been stopped, and in the Himalaya proper thanks to the Forest Department there has been a great increase in forest growth during the last fifty years.

Space does not admit of following our author through his interesting speculations on the great race movements into India. He follows most modern writers in thinking that the Dravidians preceded the Aryans, and that Scythians, who came from Eastern Europe and Western Asia, also entered India from the north-west through the Panjab, which forms the natural roadway some 200 miles broad between the Himalaya on the north and the deserts on the south. The striking similarity of the archæological remains found at Harappa and Mohendjo Daru in Sind and the Sumerian remains found at Ur of the Chaldees seems to suggest that the people concerned were of the same race or origin. Did they go from Mesopotamia to India or from India to southern Iraq? In view of the fact that the tract in India where these old cities are found is one of the oldest geologically, whereas Southern Iraq is a recent formation of the great rivers, it seems not unlikely that they went from India, and if so India can claim to be the earliest home of old-world civilization.

The labours of Sir John Marshall and his Department of Archæology have helped history in other areas. Taxila, the great watch-city built and rebuilt by successive waves of invaders on the main road from the Western passes to the Panjab about 44 miles north-west of Rawalpindi (which has taken its place and is in an even stronger position), has recently been explored and excavated by the Department, the work having been undertaken by the Panjab Government in 1910. This has shed much light on moot historical problems, such as the Kushâns. Our author has benefited and his account of all these race-movements is terse and interesting, and embodies the latest theories, but as he is careful to point out, these are only as yet theories.

It was these three waves of Dravidians, Aryans, and Scythians that stamped their character on the present peoples of the Panjab. The Mongols who followed the last were temporary though grievous pests, and were probably responsible for the wrecking of the old irrigation systems and general civilization of the area affected by their raids, just as they gave Buddhism its death-blow, and revived the present poorer form of Hinduism. It is worth noting that the author accepts the old theory, which has always been held by the Afghans themselves, and which holds the field, that the Afghans who conquered the Aryan Pathans in Afghanistan before 1000 A.D. and subsequently overran the Trans-Indus and western Panjab, were descendants of the lost 10 tribes of Israel, whom Sargon of Nineveh settled in the mountains of the Medes. For long our linguists said this was impossible as their language had an Aryan basis, but science also is still not certain, and theories change, and the language test of origin is one of the discredited theories. It is not impossible that the Baluchis who conquered the country south of Afghanistan were of similar origin. In addition to the Vesh, or periodical distribution, the Afghans brought with them the Jewish custom of dividing the land in strips, of which the result was that in the course of time

fields resembled the definition of a line—length without breadth. It was not always the case that the approach of the Vesh voided all efforts at improvement. In Buner, for instance, every one did his best to furbish up houses, etc., before the Vesh, partly for honour's sake and partly because he hoped to derive similar benefits in his new holding and home.

The author traces the rise of early Vedic Hinduism and of Buddhism, and the cause of the fall of the latter and the birth of modern Tantric Hinduism and Brahminism, and the reaction of these on the early social and economical history of northern India, with which and not only with the Panjab his account largely deals. The Panjab, lying across the road of all invasions from the North-West, suffered and benefited most from such incursions; and owing to them no doubt, aided by its fine but rigorous climate, it has become the breeding ground of the finest Indian races. Already known as most fitted for war, the Panjabis have been declared by the Labour Committee of the early 'nineties to be by far the best mill hands and craftsmen in India, and with the present spread of education they have produced excellent medical and veterinary officers and agricultural experts, and will no doubt soon develop a race of practical scientists. After all race and climate must tell.

In dealing with these movements Mr. Trevaskis naturally lays stress on the geographical features, which here as so often elsewhere have determined history, and especially on the rivers which have given their name to the Province, and his sketch-map facing page 4 is clear. He might for the uninitiated have explained that the Doábas or tracts between each pair of rivers had got their names also from their streams. Thus the western-most doába between the Jhelum and the Chenab is the Chaj, that between the Chenab and Ravi the Rechna, that between the Bias and Ravi the Bari, and that between the Bias and Satlaj the Bist or Doáb *par excellence*. The motto of the Panjab coat-of-arms is *Crescat e fluviis*, and seeing that in the past fifty years the area irrigated by these rivers, mainly from desert wastes, has risen to 11,000,000 acres and is still increasing by leaps and bounds, there never was a more warranted motto.

Mr. Trevaskis is rather inclined to undervalue the agricultural work done by Government in the past and to vaunt the labours of the new agricultural department. No one would decry these, now that they have learnt to study native practice and the reasons for this. It was not always so. In the early days the Department proposed to stop sugar-cane cultivation in the Panjab on *à priori* grounds of inadequate rainfall, etc. Fortunately their proposal, which might well have started a rebellion, was nipped in the bud, and they have now found that in parts of the Panjab the soil and climate are most suitable for cane of excellent quality and high out-turn. The much-vaunted American system of dry cultivation has been practised by Panjab peasants for countless centuries, and they also sow pulses with wheat as well as in rotation on dry lands, as this secures one crop at any rate and improves the land, though they did not know that this was due to fixation of nitrogen in the soil by the pulses. In agriculture an ounce of practice is worth a ton of theory, but this has been realized, and the present efforts of the Department are hopeful and fruitful. Still, he is the benefactor who makes two blades of grass to grow where only one grew before, and the State canals are agricultural improvements of national and even universal importance with which no Departmental improvements can hope to compete.

Coming down to historical times our author relegates dates to an appendix and tries to view "the life of the immense mixed multitudes of a country which is a museum of economics and sociology." He shows how the village communities, which are still such a prominent feature of Northern India, came into existence, and how they held on despite the legions of foreign invaders thundering past

and the even more deadly attacks of chaotic internal disorder. The lover of the picturesque will miss the personal tales and touches of old-fashioned history, but with the appendix he can from this book form a clearer idea of how modern India came into existence. Even the Moslem invasions and conquests did not uproot these sturdy villages, though some sought protection by an outward change of faith, and it is not uncommon in the Central Panjab to find adjacent villages held by men of the same stock and parentage, who in some are Muhammadans, in others Hindus, and in others again Sikhs, but creed apparently tells and the relative prosperity of the owners usually rises in the same order of creeds. The author's views on ordinary history since Nadir Shah's invasion in 1739 are more open to question, especially in their severe animadversions on British Policy in the Sikh and Afghan wars. There is a good case for the government in each of these, but it is not possible in a short review such as this to state it adequately.

In chapter v an account is given of the formation of the British administration in the Panjab and its gradual consolidation and development. The great deeds of the early officers are duly applauded, but the author might have mentioned that it was another Ulster man, Sir Robert Montgomery, who disarmed the garrison at Mian Mir and so saved the Province. It is worth noting that for all his more robust methods Sir John Lawrence created fewer foes amongst the Panjabis than Sir Henry, who was regarded by some as of uncertain temper. The Panjab Sikhs and Moslims both rather appreciate robust administration, and it is perhaps fortunate that Sir John was the Chief Commissioner in 1857 and not his brother with all his pleasanter qualities, though both were great men.

The account of the gradual formation of the present system of administration is good, but the author is open to the charge of undue denunciation of the Courts and lawyers and all their works. It is no doubt true that in this matter as in many others, and as we are now doing in the matter of representative self-government, we did try to introduce too suddenly our own ideas of what was good practice amongst a people and in a state of social conditions quite unsuited for such radical reforms. But the fact remains that our Courts with all the defects of their legal chains and trappings were infinitely superior to anything that had ever been seen in the Panjab, and on the whole were well accepted, except of course by disappointed litigants. The people would no doubt have been better off and happier if the old patriarchal order under which officers were to be guided by justice, equity, and good conscience, if no other law appeared applicable, could have been indefinitely continued, but this was a counsel of perfection in view of the measures taken in the rest of India and of the general feeling of the Panjabis themselves. As it was, thanks to the knowledge and tact of the old Panjab officers, safeguards of the interests of the people, and especially of the cultivators, were inserted as statutes were applied, and the resultant troubles were minimized.

This was especially the case in the matter of the assessment of revenue. The author gives the modern view of the growth of Hindu nations in India from patriarchal groups of nomads, through the formation of clans under chiefs first pastoral and then settling down to rude agriculture with chiefs holding a special extra share of the land of the clan, to the agglomeration of these under kings, who eventually asserted their claim to a quarter share of the produce of all lands. This condition of affairs was upset by the Muhammadan invasions bringing with them a general idea of equality of status of all and of tithes for the head of the state, which was modified by previous Hindu practice into that of a Supreme Ruler and practical state ownership or overlordship of all lands. This eventuated under Todar Mal and the other expert advisers of Akbar, mainly Hindus, who

have always led in matters of revenue arrangements, into a land-revenue system on which our present organization is based, though Akbar's arrangements were from time to time disorganized by anarchy and disorder. Our own system also, though it works so smoothly now, would only be possible under a strong, settled, and peaceful government. If such is weakened and distracted by popular clamours and fanciful experiments, the system cannot be maintained, and India will lose its most stable source of revenue, though the doctrine of ultimate state overlordship on which it is based should appeal strongly to all Socialists. In the Panjab the village communities were strengthened by us, and the settlement contracts were generally made with them. The early settlements based on Sikh demands and the practice of the North-Western Provinces were naturally heavy, but the rapid advance of the province under them showed that they could be paid, and the settlement officers found ways of making the system more suitable to the province. It is quite true that the old assessment statistical guides were perhaps subconsciously cooked, and rates of out-turn per acre and prices were adjusted to bring out a rates-demand more or less agreeing to the actual demand which on a careful inspection of the estates the Settlement Officer felt that he could properly make. Yet it was one of these officers dealing with one of Mr. Princep's Settlements who pointed out the fallacious system adopted, and how dangerous it was for the real interests of the State to make it appear that government was taking approximately the full one-sixth of the gross produce to which as ultimate owner it was entitled by tradition and statute, when it was notorious that it was only taking about one-twelfth. Such a policy of self-deceit could only afford an excellent opportunity to those who, as in the present Bardoli case in Gujrat, challenge the Government revenue system as tyrannical and exorbitant. It was this representation which led to the issue of the order by Sir J. Lyall mentioned on page 277 that a preliminary report on rates based on facts should be submitted before and independently of any suggestions of actual rates to be used in assessment. These reports soon showed how much the actual revenue was below the legal demand, and explained the great rush from 1870 to 1898 by moneylenders and capitalists to acquire agricultural land. It is however hard to protect a peasant against himself, and peasants turned moneylenders, as is common now in the prosperous Central Panjab, are often the worst blood-suckers. Even the great colonization schemes might have failed, as the Sindhi colony partly failed, if the colonists had been given proprietary rights straight off. Had this been done, their holdings would have passed into the hands of the larger owners and capitalists, and the Panjab would not have shown an import of £4,000,000 in gold a year mainly absorbed by the cultivators as it did before the Great War. It was their status as occupancy tenants of Government that saved them from themselves, and this should be borne in mind in the case of all new colonies.

The final chapter "Conclusion" is a good summary of the author's thesis. Even if his generous enthusiasm for one of the finest bodies of peasants in the world has led him to denounce somewhat unmercifully whatever seems to him to have militated against their interests in our administration, he has done a great service to all students of Northern Indian sociology and economics by compiling this very valuable guide, as he himself puts it, to the study of the leading authorities on these subjects. In his arguments he follows his hero Mr. Thorburn, of 'Mussulmans and Moneylenders,' who undoubtedly did so much for the peasants of the Province, though his methods of advocacy nearly wrecked the cause that he had at heart.

There are mistakes mainly typographical in several of the vernacular terms in the notes and appendix, which should be corrected in a new edition. Thus the

poll tax is sometimes written jaziya and sometimes jiziya; a grant for subsistence is Madad Maash without a comma. Theh, an old village site, is written Thekh, Bahowalpurum instead of Bahawalpur; Kharkhanda instead of Kharkhauda; Sukarcharia for Sukarchakia. There are other oversights; thus the page references on page xiii are incorrect, and on page 354 the annual rainfall of Gurdaspur is given as 75·80; on page 140, by an obvious misprint Ahmad Shah Abdali is said to have finally invaded India only two years after Nadir Shah instead of over thirty years. On page 74 in the Appendix *dhaya* is said to mean the low valley of a river—it is really the old high bank of this; and on page 14, in the inscription on the Dewan-i-Khas of Delhi the word for paradise is *fardús* and not *bihisht*, and the inscription runs: *Agar fardus ba rui zamin ast, hamin ast wa hamin ast, wa hamin ast*. As a matter of fact, too, present Delhi or Shah Jahánábad, though founded by Shahjahán, took, like New Imperial Delhi, many years in the building and was not used much by him. *Absit omen* / LOUIS DANE.

THE POPULATION CAPACITY OF AUSTRALIA

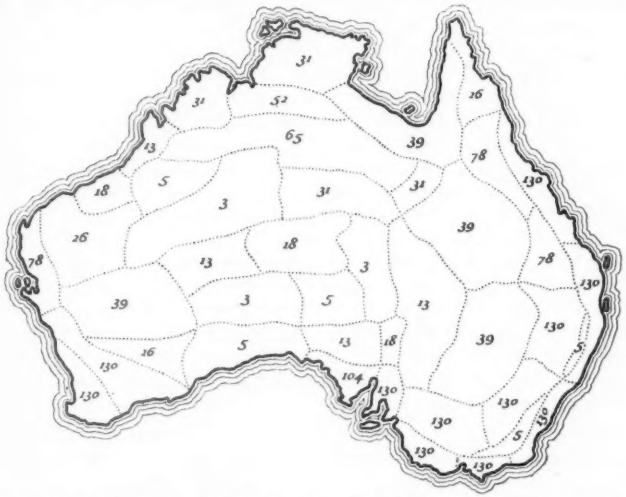
DIE WIRTHSCHAFTS- UND LEBENSRAÜME DES FESTLANDES AUSTRALIEN. Von WALTER GEISLER. (Koloniale Studien; Hans Meyer Festschrift. *pages* 199–222; *pls.* 4, 5.) *Berlin: Reimer & Vohsen* 1928

THE number of inhabitants which Australia, if suitably developed, could support is of interest in connection with the problems of European migration besides being the determining factor of the future of the continent. The interior of Australia has such a low relief and is so far from the sea that the rainfall is small and the land has a low stock and population capacity. Australia, on the other hand, enjoys many great natural advantages. Gradients in the interior are gentle, so that transport is easy; and as Australia is the only large land area in the South-Western Pacific it should in time find rich markets for foodstuffs and manufactures in the South Sea Islands, which, owing to their fertility in tropical products, should ultimately have populations as dense as those of Barbados and Malta.

Some authorities, impressed by the aridity of the interior, consider that the growth of the Australian population will be slow and the maximum less than 50 millions. Such are the estimates of Prof. Griffith Taylor, Prof. E. M. East, and Sir Charles Close. On the other hand, a calculation I made some years ago gave the future population as 100 millions; that figure has been often adopted, but it was rejected as a ridiculous underestimate by the late Admiral Sir Edmond Slade, who was confident that Australia would reach a population of 200 millions.

The latest detailed estimate is by Prof. Walter Geisler, of Halle: it was prepared after a long tour in Australia, especially devoted to this problem. He divides Australia (exclusive of Tasmania) into 43 divisions and has estimated the population capacity of each. He calculates that Australia and Tasmania could together maintain a population of from 150 to 200 millions. His conclusions may best be illustrated by the accompanying sketch-map, which shows Geisler's 43 divisions and his estimate of the density of population per square mile which each of them could support. The rates vary from a maximum of 130 per square mile for the eastern and part of the southern coasts and the wheat area of the south-western corner, down to 3 per square mile for the two great desert areas on the western interior. Probably no two students of the subject would agree even as to the relative capacities of these divisions. The estimates of 5·2 per square mile for the Blue Mountains of New South Wales and for the Australian

Alps of Victoria, each of which he describes as a "Sperrland" or barrier belt, seem unduly low; while 39 per square mile for the west central division of Western Australia seems relatively too high. The map calls attention to features which are often overlooked. Thus while it draws a barren crescent with a possible density of 3 to 5 in Northern South Australia, it assigns to the area still farther inland, the new province of Central Australia, populations of 18 and 31 per square mile, and of 65 per square mile to the downland belt including Hall's Creek and Powell's Creek. The higher population-capacities of these three divisions is the justification for the extension of the railway northward from



The Population Capacity of Australia after Geisler: the Figures represent Capacity for Inhabitants per square mile

Oodnadatta in preference to the completion of the trans-continental line to Port Darwin across the western plains of New South Wales and Queensland.

Prof. Geisler's estimates show the opinions formed by a friendly critic of the possible contribution Australia might make to the future of the European race. His results, being twice the reviewer's own, seem optimistic; but they are not to be dismissed as fantastic. They represent what Australia might attain if the interior and northern tropical regions were developed on sound lines concurrently with the growth of the industrial and agricultural regions of the eastern, south-eastern, and south-western coastlands. Prof. Geisler has a firmer faith in the future of Australia than some Australian officials. J. W. G.

REVIEWS

ITALY'S ÆGEAN POSSESSIONS. By C. D. Booth and I. B. Booth. *London: Arrowsmith* 1928. 9×6 *inches;* 324 *pages; illustrations and a map.* 16*s*

The Introduction gives the clue to the main purpose of this book, which is to set forth the strong case of the Dodecanesians for self-determination, and their inherent right to unite with their Motherland, Greece. The twelve small islands in the Ægean Sea have sustained many adversities through frequent conquests and occupations from ancient times down to the present day. But Turkish rule, which lasted four centuries from the capture of Rhodes by Sulieman in 1522, was far less oppressive than in most of the Porte's colonies; by the favourable terms granted in successive Firmans, the people were, in a large measure, autonomous. The chapters dealing with later events in the island, which by their strategic position became a pivot in the policies and treaties of European Powers, and their present status under Italian government, give a painful impression of wrongs done to "a homogeneous people with a high degree of civilization and a political philosophy essentially democratic and Greek."

The islands are rich in classical associations, in famous names representing all the arts, in religious and secular legends, and historic buildings. The authors' account of the sieges of Rhodes, by Moslem hosts opposed to the Knights of St. John, justifies their claim that we have here "one of the most dramatic chapters of medieval history." The renowned Patmos and its monastery; the treasures in the churches and the Museum at Rhodes; its fifteenth-century "Street of the Knights"; the massive architecture of old fortresses and towers—all these are described, with excellent illustrations, and may well attract travellers to this hospitable group of islands. M. K.

THE EMPIRE OF THE GREAT MOGUL: A Translation of De Laet's 'Description of India and Fragment of Indian History.' Translated by J. S. Hoyland, M.A., F.R.HIST.S., and Annotated by S. N. Banerjee, M.A. *Bombay: Taraporevala Sons & Co.* 1928. 7×5 *inches;* xiv+252 *pages. Rs.*5 *as.*8

De Laet, though never in India, was a Director of the Dutch East India Company, and published in Latin, in 1631, four years after the death of Jahangir, a compilation "according to the observations made during recent years by men of various European races—Portuguese, English, Dutch." The geographical portion summarizes, largely in the form of itineraries, what was known of the thirty-seven provinces of Northern India in the early part of the seventeenth century. Descriptions are given of places of interest; there are occasional references to products and trade, to the dangers of the roads, and the character of the people. North-Western India from Cabul and the Gulf of Cambay to Allahabad is naturally most fully treated. Little is said of Bengal, a recent addition to the Mogul Empire, or of Southern India; indeed, the limit of India to the south is made lat. 20° N. The Kingdom of Golconda with its diamond mines is however described, and the Konkan, the Western Ghats, and the Deccan, are referred to in "Cuncam . . . is a coast district reaching back to the mountain range called Guate . . . beyond its top is, strange to say, a very beautiful plain." In other chapters an interesting account is given of the Royal Court and Citadel of Agra (Shah Jahan's Delhi was not yet built), of the nature of the government, and the condition of the people, the contrast between the luxury of the nobles and the miserable condition of the peasantry being strongly brought out.

The translation of De Laet's Latin has been well done. The notes are most useful, but the general reader would have been still further helped had proper

names been in all cases modernized. "Gorom" and "Xa-Ziahan" are not quite obviously "Khurram" and "Shah Jahan." W. H. A. W.

THE STATION. ATHOS: Treasures and Men. By ROBERT BYRON. *London: Duckworth* 1928. 9×6 *inches;* 292 *pages, and illustrations.* 18*s*

This well-produced and illustrated book is the record of a privileged visit, paid by the author and three friends, to the Holy Mountain in 1927, which not only enabled him to make an intimate study of the unique "independent republic," but also opened to his view the monastic treasures of Byzantine art—*eikons*, manuscripts, mosaics, and jewels.

From Athens, where he found "history woven with the days, not years," Mr. Byron went to Caryes, the metropolis of the peninsula; to the Lavra, with its exquisitely wrought fountain and wonderful tenth-century Bible; and thence to each of the outlying communities. Remote and primitive though these appear, life in the Athonite monasteries is secure and civilized compared with that of Syrian Catholic or Chaldæan monks in Mesopotamia—especially the little group who still inhabit the lofty cave-dwellings of Rabban Hormizd.

Mr. Byron is an experienced traveller and student, and his book is a valuable addition to the impressions of Mount Athos gained by earlier visitors; though overlaid with material which belongs rather to a volume of "light" travels, and with comments on the universe in general, made in a vein of pagan humour and somewhat mannered diction. It is due to Mr. Byron's modernity that, while he spares us no grotesque or ugly detail which came in his way, his pages reflect, too, vivid images of beauty in sea and coast, trees and flowers, and strangely tinted Byzantine buildings towering in "the aer so clere and subtill," observed by Mandeville. A notable chapter is devoted to the ascent to the summit of Mount Athos, crowned by the Church of the Transfiguration—"reared a mile and a quarter off the globe." M. K.

FARMS AND FANES OF ANCIENT NORWAY. By MAGNUS OLSEN. *Oslo: H. Aschehoug & Co.; London: Williams & Norgate, Ltd.* 1928. 8×5 *inches;* xvi+350 *pages.* 8*s* 6*d*

These lectures, which were delivered to the Institute for Comparative Research in Human Culture at Oslo and are translated from the Norwegian by Th. Gleditsch, attempt according to the sub-title of the volume to discuss the place-names of a country in their bearings on social and religious history. It is pointed out that Norway has no ancient villages: the farm was the unit of settlement, and the farm-names have often ousted even the old river and mountain names. It is suggested incidentally that Oslo may have been originally a farm; and its derivation is confidently stated to be from *áss* (god) and *lǫ́*, the same as Old English léah (meadow). By elaborate analysis of the name-classes the farms are grouped according to their high or low social importance, their joint or individual ownership, and their central or outlying position in the growing settlement. The names given by the Norse settlers in Iceland (and to some extent in Shetland) are brought into the argument. It is a difficult book to read; and we are left with the feeling that the place-names have been worked to death. The author mercifully admits the impossibility (at present) of extracting from them a detailed account of prehistoric settlements. J. H. R.

THE GEOGRAPHICAL BASIS OF EUROPEAN HISTORY. By J. K. WRIGHT. *New York: Henry Holt & Co.* 1928. 7×5 *inches;* viii+110 *pages; and sketch-maps.* $1

This sketch of geographical factors is one of a series designed to deal with "topics . . . on which there is no e asiy accessible reading of appropriate length adequate for the needs of a course in general European history." Dr. Wright

treats his subject lucidly and attractively, without forcing the "geographical basis" to explain too much. "It is man," he writes, "not man's environment, that builds cities. . . . Where the conditions of geographical environment are favorable men may, and often do, take advantage of them, but not inevitably," and this is his attitude throughout. His four physiographical divisions, the Africo-Arabian arid region, the Alpine Mediterranean region, North-Eastern and North-Western Europe, lend themselves naturally to discussions in turn of the expansion of Islam, Mediterranean ports and city-states, the growth of Russia, and modern industrial communities. One notes the omission of any consideration of Carthage and her rival Empire to Rome. There is, altogether, much to reflect upon and consider—rather more, in fact, than could be digested by a class in the "week's reading" for which the book is designed. G. R. C.

DACIA: AN OUTLINE OF THE EARLY CIVILIZATIONS OF THE Carpatho-Danubian countries. By VASILE PÂRVAN. *Cambridge: University Press* 1928. 7×5 *inches;* x+216 *pages; illustrations and map.* 7*s* 6*d*

By the death last year of Dr. Pârvan, Professor at Bucharest University and permanent Secretary of the Romanian Academy, the study of the ancient world has lost a most versatile and profound scholar. This book, published posthumously, reproduces a course of lectures which he gave at Cambridge shortly before his death. It has been carefully edited and does full justice to his memory.

The author throughout gives us a mass of material well arranged and carefully selected, but he never loses the bird's-eye view which it is so essential in a work of this kind to keep throughout. The area with which he deals is homogeneous. It is bounded by the Danube on the west and south, the Dniester on the north-east, the Black Sea on the east, and the upper bend of the Carpathians on the north. In its widest version the area can be extended as far as Praha on the north, the Crimea on the east, the Adriatic on the west, and the Ægean on the south. But the irreducible minimum roughly corresponds to the present area of Romania.

Without overemphasizing the geographical aspect the author has, in fact, given us a most valuable study in the influence of geography on history. His main thesis is to show that the history of Dacia in Roman times is the logical sequel to its history in the late Bronze and Early Iron Age. In the first chapter he shows how, by a gradual process of infiltration and commerce, the highly developed Iron Age of the Venetic regions first absorbed and then controlled the Bronze-Age culture of the Hungarian plain and the plateaux of Transylvania. As this Bronze Age was by far the most highly developed and brilliant of non-Mediterranean Europe, the vigour of the Venetic Iron Age must have been remarkable. The result of the fusion of the two cultures was a period of great economic prosperity. Pârvan compares it to the similar fusion of enterprising Achæans with wealthy Mycenæans. "The Social life," he says (p. 26), "of the natives of the immense region lying between Bohemia and the Ukraine, and Dalmatia and Bulgaria, offers a series of phenomena very similar to those of the 'Achæo-Mycenæan' Mediæval period. Our experience of the actual sites and in the archæological atmosphere of the period has led us to the conclusion that the *Iliad* and the *Odyssey* may well serve, for the future, to illustrate many aspects of the proto-history of the natives of the Carpathians."

This great period of prosperity, when local princes loaded themselves and their tables with jewels and plate in Transylvanian gold, was hardly affected by the Hallstatt version of the Iron Age. Iron did not reach them to any appreciable extent until soon after 700 B.C., when the first of the Scythian inroads

from the east virtually destroyed the very Occidental culture that had been built up. These invaders were not the wealthy and semi-civilized Scythians of South Russia, but a ruder and simpler folk. They settled in three compact groups—in Northern Hungary and Slovakia, in Southern Transylvania, and in the Wallachian plain. Here Dr. Pârvan has made a most notable contribution to knowledge, for this clear distinction of the Scythian invaders into groups was not hitherto known. These Scythians were in close touch with Olbia, and for this reason we find very exact information about them in Herodotus.

The invasion was at first catastrophic, but after a time the natives reasserted themselves, and the Scythians continued more or less isolated in *enclaves* (see p. 52). Their arrival was a disaster because it stopped the commercial prosperity of the country and endangered the trade routes. But they seem to have been absorbed in the end without materially affecting the racial characteristics of the natives. Pârvan compares these Scythians with the Dorians (p. 69) in their effects; the invaders settled down and were partly assimilated, but the native nobles and richer classes were killed off. The Iron Age proper in these parts begins with the Scythians. The description of the pomp and splendour of the Agathyrsi in Herodotus refers not to the Scythians but to the Bronze-Age nobility that had preceded them.

Of the Greek penetration of Romania from the east we are fully informed by Pontic excavations and by the discovery in the hinterland of sufficient Greek material to enable us to conclude that "even as far afield as Bucharest, Plœşti or Turnu Măgurele, one has the impression of being in the rural territory of some Pontic city such as Istria, Tomi or Odessus" (p. 106). But here Pârvan maintains strongly that Greek culture "did not succeed in forming a specific Daco-Hellenic culture in Dacia."

In the third century B.C. the West succeeded where the East had failed. Just as the Scythians made no mark while the Venetic peoples had completely influenced the Carpatho-Danubians, so where the Greeks failed the Celts, coming over the same routes as the Veneti, succeeded. The Carpatho-Danubian region had always faced West; and the Celts brought with them in the shape of their splendid material civilization (known as the La Tène culture) influences which could only result in Rome as a sequel. The Celts were the forerunners of the Romans, who first appeared as traders and prospectors. The flag followed trade, and it was only a matter of time for the Legions to make their way into these wild and unknown lands, for the natives were accustomed since the Bronze Age to Western influence. Even in the Christian Era it was the Roman Church rather than the Greek which affected the people, as the name for church in Romanian—*biserica* (=basilica) indicates when we contrast it with the *église* and *chiesa* which are of Greek origin. Latin soon became the diplomatic language of the Dacians, and the widespread settlement of veterans (who have left their traces in the Romanian word *bătrân* (=old) soon achieved a considerable Latinization of the land.

Dr. Pârvan has left us a notable little book, refreshingly simple, free from special pleading, and deeply learned. He can handle the material of each period with equal ability. There is little to criticize and nothing to complain of (unless it be the absence of a scale on the map). In one respect the author's judgment must be doubted: the bronze figure of "Apaitis" on Pl. 7, now at Bucharest, seems to the reviewer to be certainly mediæval, and he cannot fathom the editors' complete omission in the bibliography of Histria VII, which he received from Dr. Pârvan's own hand. But in all other respects the book is a model of good editing.

The ethnic character of the Getæ is, alas, still left rather a mystery. We are

told that about the year 1000 B.C. the "Carpatho-Danubian countries were inhabited by a northern branch of the Thracians, and near them were the Cimmerians, who are thought to have a Thracian origin." Yet in the time of Burebista we find the Thracians south of the Danube most clearly distinguished from those of Dacia. It would be interesting to know what percentage of Scythian and Thracian blood was in the average Dacian.

Throughout Dr. Pârvan contrasts the Hellenized Balkans with the Romanized Danube. Here, conceivably, we meet the only prejudice that affected him. It is the general Romanian assertion that Romania is not a Balkan state. This is true enough, but until the enlargement of her borders she was, politically and socially, Balkan to the core. Now once more she faces west, as in the days of the Veneti and their followers the Romans. STANLEY CASSON.

THOSE ANCIENT LANDS. By LOUIS GOLDING. *London: Ernest Benn* 1928. 274 *pages, and illustrations.* 12*s* 6*d*

This collection of travel impressions is rightly described by the publishers as "a romantic fantasy," and the author himself writes, "I do no more than describe the Palestine which I saw with my own eyes, always with such emotion, often of pride, sometimes of apprehension." This comes out most prominently when he writes of the Jewish colonists. With all his sympathy he gives the impression of a sceptical attitude regarding the outcome of Zionism. Pride in his race makes him less than just to the other inhabitants of the Holy Land—the Moslems, and even more the Christians—and one feels that such an attitude bodes ill for the success of that cooperation between the various semitic elements in Palestine which is essential if the land is to prosper. Although sketches of Jewish life predominate, there are no more attractive chapters than those on the "Excluded Country" and "Evening in Nazareth." Compared with so many recent books which profess to describe "a journey in Palestine," this volume has the merit both of originality and of literary ability. Some may admire the three modernist pictures of Palestine buildings. E. W. G. M.

PALESTINE OLD AND NEW. By ALBERT M. HYAMSON. *London: Methuen & Co.* 8×5 *inches;* xii+288 *pages; illustrations and a sketch-map.* 7*s* 6*d*

This, unlike so many recent volumes dealing with Palestine, is not a book of travels but rather a guide to the would-be traveller, along oft-trodden paths. It is clearly written and packed with up-to-date information. Controversies, religious and archæological, are avoided, and no special theories are promulgated. The author gives well-known facts—historical and archæological—connected with the various localities described. The material is arranged geographically along readily traversed routes. It is a volume which can be thoroughly recommended to the tourist *en route* for Palestine. E. W. G. M.

AUF HELLAS SPUREN IN OST-TURKISTAN. By Dr. A. VON LE COQ. *Leipzig: J. C. Hinrichs* 1926. 9×6 *inches;* xii+166 *pages; maps and illustrations. M.*12

VON LAND UND LEUTEN IN OST-TURKISTAN. By Dr. A. VON LE COQ. *Leipzig: J. C. Hinrichs* 1928. 9×6 *inches;* viii+184 *pages; illustrations and maps. M.*12

In these two books Dr. von Le Coq describes the three German Turfan expeditions in which he participated—being himself in charge of two—in the years 1904–05, 1905–07, and 1913–14. The rich store of artistic treasures brought back from these expeditions may be seen to-day in the Berlin Museum für Völkerkunde, where they are exhibited to the greatest possible advantage. They consist mainly of mural paintings, which, having been cut out in sections and

conveyed to Europe in packing-cases, have been set up with such skill that hardly any traces of the operation can be observed: in many cases the actual rooms have been structurally adapted to the frescoes. The priceless literary finds, comprising as many as seventeen different languages and twenty-four different scripts, are also housed in this museum, and many volumes and pamphlets containing reproductions and descriptions have already appeared. The two books now before us represent a more or less popular account of these expeditions and their scientific results, intended primarily for those who are not likely to come across the purely scientific works just referred to.

Although these little books aim only at offering a simple narrative to the general public they are full of the most curious and valuable data, and in view of the newness of this field of research cannot be classed as unscientific. Taken however as mere books of travel they make excellent reading, for the author is not only a fearless traveller, but at the same time a first-class narrator, with a fund of humour and a subtle understanding of Eastern peoples. The archæological results so admirably summarized in the Introduction to the first of these volumes must for the majority of readers open up entirely new visions of history and new trains of thought. The most salient features that emerge are: (1) that Turkestan until comparatively recent times was peopled not by Turks but by Iranians whose culture was Western rather than Eastern; and (2) that this country has held hidden for centuries the missing link between Græco-Indian art and the plastic and pictorial arts of China and Japan. The second book, which deals with the fourth German Turfan Expedition, tells us more about the country and its people as they are to-day. Attention must, however, be drawn to the Introduction to this volume in which the highly romantic story is told of the manner in which the documents brought back from the three previous expeditions were deciphered; how new languages were read; how new versions of Buddhist and Christian literature were revealed; and how the first specimens of the long-lost literature of the Manichæans were identified, all by the patient and inspired labours of a small group of scholars, notably by that great linguist, Prof. F. W. K. Müller, who possesses a working knowledge of every literary language of Asia. These little books are copiously illustrated with photographs of people and scenery and of archæological finds. It is perhaps difficult for the general reader to realize how much here is totally new except to those who have closely followed the history of Central Asian exploration during the last three decades.

There is one episode in these pages which seems to deserve wider publicity among our countrymen than it has hitherto had, and it is one which will certainly make a strong appeal to readers of this *Journal*. Owing to a native revolt in the autumn of 1906 Dr. von Le Coq was obliged to make his return journey over the Karakoram, and as he had for some time been unwell, Sir George Macartney (then Consul-General in Kashghar) suggested he should join company with Capt. J. B. Sherer, an artillery officer who was returning to his headquarters at Quetta. While crossing some of the first passes Sherer fell sick, and with great difficulty he was brought as far as the camp at Burtsi on the Indian side of the Karakoram pass: here they took a day's rest, but on the following morning Sherer was unable to move at all, having been delirious all the night. In this situation von Le Coq made the generous resolve to go for help, and leaving Sherer with the only tent, his servants and supplies, he himself proceeded with the caravan over the three remaining passes, the most difficult of the whole range, leading to Tibet. For provisions he had nothing but flour, which his Turkish servant made into "balls" with the addition of glacier water. In eight and a half days they crossed the Murghi, Saser, and Karaul passes and entered

the valley of the Nubra, finally reaching the little Tibetan village of Panamik, in Ladak, where he was able to procure chickens, eggs, milk, and other luxuries. He sent a message to Sir Francis Younghusband in Srinagar (seventeen days' journey), telling him his story and begging him, in the event of his not returning, to send to Panamik for his packing-cases and to forward them to Germany. He also sent a message to the Medical Mission at Leh, telling them that he was going to fetch Sherer. With an improvised litter and thirty Tibetan coolies he made the return journey over the three passes in three days, and on arrival at the camp found Sherer somewhat restored, though still too weak to sit on a horse. They immediately set out again, and while the path was wide enough Sherer was carried in the litter, but in the narrow places he had to be borne on the back of a coolie. The description of the crossing of glaciers, passes, and rivers with the sick man makes thrilling reading, though told with the writer's wonted simplicity and modesty. When they reached Panamik they found the caravan still there, and a messenger from Leh with medicines, and on November 4 the party finally reached Leh in safety, and there Sherer was obliged to remain six months in hospital. Those who know the Karakoram will readily appreciate the difficulties of the task von Le Coq so unselfishly undertook of crossing those passes three times in a month. It must be further borne in mind that von Le Coq was no longer in his first youth and that he had just spent two years carrying out excavations in an exceptionally trying climate. E. D. R.

DE OOST-INDISCHE COMPAGNIE ALS ZEEMOGENDHEID IN AZIE (1602–1650). Door N. MACLEOD. Two volumes and atlas. *Rijswijk: Blankwaardt & Schoonhoven* 1927. 10×6 *inches;* vii+528, vii+486 *pages; maps and plans.* 20 *guilders*

This is, in the reviewer's opinion, the best historical work dealing with any phase of European expansion in the East that has appeared for many years, and Admiral Macleod has laid under a great debt to him all students of the history of European colonial development in Asia.

Compared with most of its predecessors, which are mainly collections of documents, the present work has the advantage of being written as a continuous narrative with only occasional quotations from the original sources and those judiciously selected.

Admiral Macleod is brief when dealing with matters already treated at length by De Jonge or the monumental *Dagh-Register* of Batavia, but gives in full detail the events of those years for which the *Dagh-Register* is lost, or on which other writers touch but lightly; and when it is added that he has drawn for his material solely upon unpublished documents in the Rijksarchief at the Hague it will be realized that his work contains little but what is entirely new to most Dutch as well as to English and other readers.

The book gives us an illuminating picture of the steady growth of Dutch naval power in Asia, and the way in which the march of events forced an imperialist and bellicose policy upon what was intended to be primarily a trading company. The earlier voyages are carefully summarized and disentangled, and especially interesting is the part dealing with the blockades of Goa (1636–1644) and the slow but sure way in which the Portuguese naval Power in India was sapped by the persistent attacks of the Dutch. The part dealing with Jan Pieterszoon Coen's crushing defeat of the English in 1619 also makes interesting, if somewhat painful, reading. The outlying parts of the Malay Archipelago, such as The Moluccas, Amboina, and Macassar, are also dealt with at much greater length than in other similar works, and here especially English readers will find much that is new and interesting, whilst the Persian Gulf and Western Asia likewise receive their due share of attention.

English writers frequently err in supposing that the Dutch power decayed owing to the insupportable burden of maintaining great fleets and armies, and that their English rivals owed their prosperity to following Sir Thomas Roe's advice to "seek their fortune in quiet trade;" but this is far from the truth. The prestige and power of the Dutch, as of their Portuguese predecessors and English successors, depended in the last resort upon the force exerted by their fleets, and it was under Van Diemen, one of the most energetic and bellicose of their Governors-General, that their commercial prosperity was greatest in the period under review.

The few mistakes the reviewer has noticed may be ascribed to the fact that the author drew solely from Dutch sources and did not consult English or Portuguese records at all. By resorting to the monumental series of 'English Factories in India,' so ably calendared by Sir Wm. Foster, he would have avoided the error of placing the fall of Ormuz in 1621 (instead of 1622), and another in connection with the capture of Rui Freire (vol. i, p. 408). Again, a study of Portuguese records would have shown him that the vessel burnt by the Dutch in the action off Goa's bar on 4 January 1638 was not the flagship of Antonio Teles, the Portuguese commander, but the *São Bartholomeu* of Luis de Castellobranco; but these appear the only mistakes of importance.

Finally, a word of praise must be given to the atlas. The maps and sketches both in this and in the text are well executed, accurate, and clear, and contain only such names as are mentioned in the narrative. The index of names is very full and a model of its kind. Both author and publishers are to be congratulated upon producing so excellent a work, and it is to be hoped that Admiral Macleod will be encouraged to give us another carrying the story down to the end of the century. C. R. B.

THE INDIAN YEAR BOOK, 1928. Edited by Sir STANLEY REED and S. T. SHEPPARD. *Bombay and Calcutta: The Times of India* 1928. 7×5 *inches;* xvi+948 *pages, and maps.* 12*s*

In its fifteen years of existence the *Indian Year Book* has become an almost indispensable book of reference for those who are practically interested in the affairs of India. It combines many of the features of the *Statesman's Year Book* and *Whitaker's Almanac,* and can be fairly described as "a statistical and historical account of the Indian Empire, with an explanation of the principal topics of the day." It provides in one compact volume information that would otherwise have to be obtained from a multiplicity of official publications. The friendly cooperation of Government departments enables it to give the latest statistics. The book consists of articles, arranged in no particular order, with a full index. In addition to the standard information that such a handbook would be expected to contain there is much interesting information of a miscellaneous character. Some of the articles need to be revised, *e.g.* that on the Peoples of India. The work concludes with a useful "Who's Who in India." W. H. A. W.

CHINA AND ENGLAND. By W. E. SOOTHILL. *London: Oxford University Press* 1928. 9×6 *inches;* 228 *pages.* 7*s* 6*d*

The author of this book is evidently actuated by sincere goodwill towards China. As one who has spent most of his life in the service of the Chinese people, he cannot but feel distressed by the cloud that has for some years overhung the relations between England and China; and it is in order to discover the causes which have brought this unhappy state of things about that he begins with a review of past political history. He tries hard to be perfectly fair and unbiassed, but in most matters of dispute he seems to the reviewer to make the book an apologia for his own country rather than an impartial statement of facts. On

the other hand, after ably marshalling the facts and arguments which are put forward by the advocates of extra-territoriality, Professor Soothill finally pronounces himself in favour of its gradual abolition. This is a courageous avowal, in view of the extreme disfavour with which the proposal is regarded by nearly all foreign residents in China.

The missionary problem is disguised under the somewhat pompous title "Cultural Importations." Here the Professor becomes an apologist again, though in a burst of candour he says, wisely enough, that "Christianity might indeed be more valued if it had to be sought." The rest of the book is mainly devoted to a summary and caustic criticism of Sun Yat-sen's lectures on "The People's Three Principles," namely Nationalism, Democracy, and Socialism. The late leader was undoubtedly a sincere patriot, but his notions of political economy were so crude and his prejudices so strong that there is no fear of his work long remaining a "text-book" in Nationalist schools, if indeed it has not already been discarded.

Two minor points may be noted: on p. 138 the author speaks as though Ricci's World Map first became known in this country through a photograph brought back from China by himself last year. This is true, of course, only of the original MS. version, the printed map (the same in all essentials) having been previously known from the copy owned by the R.G.S. On p. 209 mention is made of "Wang An-shih, the Chinese Communist of the eleventh century A.D., to whose theories put into practice Chinese history attributes the downfall of the Sung dynasty." Wang An-shih was far from being a Communist in the ordinary acceptation of the term; his system had been abolished before his death in 1086, and the Sung dynasty lasted for nearly two centuries longer. L. G.

THE MODERN MALAY. By L. Richmond Wheeler. *London: George Allen & Unwin* 1928. 9×6 *inches;* 300 *pages, and illustrations.* 15*s*

This is a thoughtful and valuable study of the Peninsular Malays in all their aspects, by one who has spent seven years among them in educational capacities. Mr. Wheeler begins with a short but adequate chapter on the physical features of the Peninsula, and passes to an historical survey of the Malays from the earliest records to the present day. He then examines present conditions, and, having shown the response made under the influence of British administration, ends his book with some sound and well-balanced suggestions as to their future development. His reasoned conclusion (and few who know anything of Malaya will disagree with it) is that British influence has been for good: for the Malay's life under present-day conditions, if less adventurous than of old, is certainly more secure and more healthful. Sir Hugh Low's policy of governing the people as far as possible through their recognized chiefs has worked well, and the conservatism of the Malay has given way to his innate adaptability to circumstances, so that now (after some doubtful years) he is glad that his sons should have the advantage of the educational resources that are placed within their reach; the education of girls still presents a difficult problem, for here prejudice is harder to break down.

Mr. Wheeler's book is in no sense "popular"; it is a serious piece of work, well documented and indexed, and demands the attention of every one interested in the administration of native races. O. R.

THE LAKE PLATEAU BASIN OF THE NILE. By H. E. Hurst. Second Part. (Physical Department Paper No. 23.) *Cairo: Ministry of Public Works* 1927. 11×8 *inches;* 66 *pages; map and* 51 *photographic reproductions*

The discharge operations of 1902–1903 (described by Sir Henry Lyons in his 'Physiography of the Nile') had clearly indicated that the Blue Nile and the

Atbara, rising in the Abyssinian Mountains, were the main contributors to the flood waters of the Nile in the Northern Sudan and Egypt. The summer water supply of the river, on the other hand, was almost entirely derived from those regions in Central Africa which are occupied by the great lakes (Victoria Nyanza, etc.), and of which the White Nile is the link with the Egyptian stream.

The Lake Plateau Basin of the Nile has in consequence become a special object of study for the Egyptian Government. The expedition carried out by Sir William Garstin was the first of a series of investigations of which the journeys of Dr. Hurst in 1924 and 1926 are the natural continuation. The results of the former were embodied in Physical Department Paper No. 21, reviewed in the *Journal*, 67, p. 365. There still remained a large area in the extreme south-west of the basin which had not been sufficiently investigated from a hydrological point of view, and at the instance of Dr. Hurst the second expedition of 1926 was organized under his leadership to supply this defect, the results being described in the report now under review. Dr. Hurst was supported by Capt. W. G. Goldsack, M.C., and the total distance covered (partly on foot and partly on bicycle, the advantages of which are specially emphasized) was over 1400 miles.

The greater part of the region studied was in the Lake Victoria Basin drained by the Kagera and its tributaries, the principal of which are the Nyavarongo and the Ruvuvu. The basin of the Kagera (a large part of which is in Belgian territory) occupies about 63,000 square kilometres, practically the whole of it being mountainous country with the highest portions in the west. A noticeable feature, well brought out in some of the figures, is the presence of numerous lakes and swamps bordering the rivers in the valleys. The ultimate sources of the Nile have been definitely proved to be near Lakes Kivu and Tanganyika, the Nyavarongo drawing its supplies from the high country near Lake Kivu, while the farthest sources of the Ruvuvu are within 45 miles of Lake Tanganyika.

The upper waters of all these streams are impeded by rapids, but all of them, together with the Kagera, are navigable over considerable distances. The general conclusion drawn by Dr. Hurst is that, so far as can be seen at present, the contribution of this area to the water supply of the Nile is not large enough to justify a detailed study.

Considerable attention was devoted to the grass-covered plains, which become swamps after the rain, and are locally known as "Mbuga." They form an important feature from lat. 4° south to Smith Sound, the southern creek of Lake Victoria. Three samples of the dark soil of this region, resembling the cotton soil of the Sudan, have been examined by the well-known expert on Egyptian soils, M. V. M. Mosseri, and are described by him in Appendix IV. These soils have satisfactory porosity, permeability, and capillarity, and are very rich in nitrogen, but unfortunately this is of low availability. The origin of the organic matter which gives them their black colour has not been ascertained, but in any case they differ entirely from the Black Earth of Russia and the Cotton Soil of the Sudan. The reviewer enjoyed the interesting experience of going through the microscopic slides with M. Mosseri, and can heartily agree with his conclusion that it is possible to read from them nearly the whole agricultural history of this Mbuga region and to draw almost certain prognostications as to the agricultural possibilities. Phosphoric acid and nitrogen need to be supplied if these soils are to be successfully brought into cultivation.

Geographers and irrigation authorities alike will turn with special interest to Dr. Hurst's comments on Prof. Schwarz's pessimistic suggestion that the ordinary erosion of the rivers would in course of time open a path for the waters of Victoria Nyanza to flow towards Tanganyika and the Congo, while an earth-

quake fissure might at any moment precipitate the catastrophe. Dr. Hurst, in describing the country from Smith Sound to Beharamulo, the region of most importance in this respect (p. 11), replies that "erosion, if it is going on at all, is going on very slowly, and it will be thousands of years before erosion by streams leads to an outflow of water from Lake Victoria to Lake Tanganyika. An outflow through the country to the south of Smith Sound would be easier than the one supposed by Prof. Schwarz, but this is unlikely unless there is a general subsidence of the land south of the lake." Earthquakes might produce fissures, but such an event is highly improbable on the vast scale required by the hypothesis.

This relatively short memoir is full of matter of geographical interest, enhanced by the photographic reproductions. In addition to those depicting the rivers and swamps, special attention may be directed to the views of the falls of the Kagera, the country near Kigali and near the Bassay River, Lake Ruhonda, and the panorama and detailed illustrations of the volcanic Mufumbiro Range. (Some of the latter were taken by Father Provoost of the Lulenga Mission.) Chapter III deals with the hydrological information, especially details of rainfall collected since 1923, and gives the discharges of the Victoria Nile and of the Kagera. The results for the latter river seem to indicate that it is not of such importance in the Nile régime as has been thought. Appendix I gives useful Notes on Equipment; Appendix II deals with the methods of discharge measurement; and Appendix III with the field analysis of the waters.

Dr. Hurst's sober and concise account of the Kagera region is a valuable chapter added to the romantic history of the sources of the Nile.

W. F. H.

SOUTH AFRICA'S PAST IN STONE AND PAINT. By M. C. Burkitt. *Cambridge: University Press* 1928. 9×6 *inches;* xiv+184 *pages; sketch-map and illustrations.* 12*s* 6*d*

This book represents an attempt to unravel the prehistoric past of South Africa, as far as it is possible at present, by the study of stone implements and rock paintings. On an extended tour through the Union and Southern Rhodesia the author was able to visit a number of sites where those memorials of the past have been found. Apart from the paintings and engravings these sites are not very illuminating regarding the mode of life and culture of the prehistoric inhabitants. The evidence consists chiefly of stone artefacts. Other evidence of culture is meagre, as practically no human remains have been discovered, and not much is to be learnt from stratigraphy. The author tries to make up for this by an elaborate study of the typology of the stone implements, and therefrom suggests a classification into Lower and Middle Palæolithic and later cultures. The first is characterized by *coups de poing* strikingly similar to those of the Palæolithic period in Europe. But he is careful to dissociate himself from the view which has been put forward, that they correspond in age.

The Rock Paintings have long been known, and have attracted much attention because of their association with the interesting and expiring little people, the Bushmen, and from their similarity to the palæolithic drawings discovered in recent years in France and Spain. Examples have been given by many authors, notably by Miss Tongue in a fine series of coloured plates. The settlements most closely associated with the Paintings are those characterized by the later Cultures to which the names Wilton and Smithfields have been given from typical sites. The former is interesting, as the stone implements are almost entirely pigmy tools. The latter, chiefly found in the Orange Free State and adjacent parts of Cape Province, is of common occurrence in the mountainous

districts, where the highest development of this art is to be seen in many beautiful polychrome drawings. The author endeavours to elucidate the age of the paintings by applying the principle of superposition, which has been employed with considerable success in the study of the palæolithic paintings in France and Spain. In this, with the assistance of the different colours used, he seems to have been remarkably successful. Mr. Burkitt has undoubtedly done a useful work in showing the lines on which research can most profitably be pursued, and it is to be hoped that a sufficient number of interested workers will be found in South Africa to continue the investigation. The difficulties are considerable owing to the enormous extent of the country, and the small number of persons interested in prehistoric archæology. There seems also to be some fear that the paintings in places visited by tourists may suffer from the vandalism of that class of the community. The value of the book would have been enhanced by the inclusion of a more adequate map showing clearly and in detail all the chief sites of settlements and paintings. It is well illustrated with a number of photographs of sites and scenery, twenty full-page illustrations of stone artefacts, and ten of engravings and paintings. With the exception of the frontispiece none of the latter are coloured. A useful bibliography is added.

E. A. P.

THROUGH THE CONGO BASIN. By DOUGLAS FRAZER. *London: Herbert Jenkins, Ltd.* 1927. 9×6 *inches;* xiv+270 *pages; illustrations and sketch-maps.* 16*s*

THROUGH THE LENGTH OF AFRICA. By C. V. A. PEEL. *London: Old Royalty Book Publishers* 1928. 9×6 *inches;* xii+120 *pages; illustrations.* 8*s* 6*d*

These two books, although they differ considerably from each other in merit, can with advantage be considered together. Mr. Frazer is an old traveller who is interested in everything he sees and hears, sets down his impressions, and without any attempt at scientific record or inquiry, notes all those things which he thinks are worth remembering or telling to other people. He is not always accurate in details which deserved to be verified upon return, such, for instance, as the spelling of "hevea" (p. 56) when he discourses on rubber. And he tends to dwell a little too much perhaps on the obvious or traditional reactions of the White Man travelling in the Heart of Africa. Nevertheless the book is interesting, and having heard what the author has to say about the less-known parts of the Congo, the reader is satisfied that the book was worth writing as a good-humoured and intelligent account of the country. Mr. Frazer's criticism and remarks about the Belgian administration are apposite and just. He got on well with Belgian officials and commemorates their efficiency and kindness towards himself. He is fair in showing the magnitude of their undertaking and the lack of resources available for its fruition. His conclusion is interesting: "It is no part of my self-imposed task to touch upon politics, but the impression which the unbiassed traveller in the Congo will get, will be that the Belgians are . . . in possession of what might almost be termed a white elephant. The development of a country of this extent might well strain the resources of a larger and wealthier power, and it may easily be that a third of the country would prove a far more valuable asset to Belgium than the whole."

The author of 'Through the Length of Africa' belongs to the sad class of the consciously facetious traveller. His censure of the Belgians is ill-mannered. We prefer to accept Mr. Frazer's opinion on this subject, and hope that if Mr. Peel undertakes any further journeyings in other parts of the world, he will have more valuable experiences to record, and also that he will refrain from publishing photographs of himself in heroic attitude with trophies which include tusks,

a leopard-skin and two elephants' feet arranged in front of an espalier fruit tree in some English wall-garden. F. R. R.

THE ARCHÆOLOGY OF THE CENTRAL ESKIMO. By THERKEL MATHIASSEN. (Report of the Fifth Thule Expedition, 1921–24, Vol. 4.) *Copenhagen* 1927. 2 parts. *Copenhagen: Gyldendalske Boghandel* 1927. 11×7 *inches;* vi+328, 208 *pages; illustrations and maps.*

This is Volume 4 of the Report of the Fifth Thule Expedition led by Knud Rasmussen to Arctic North America. It is by far the most important work that has yet appeared on Eskimo Archæology, which indeed until the last few years has been too much neglected by Arctic expeditions.

Dr. Mathiassen has divided his work into two parts, the first being the description of the objects found, while the second deals with the "Thule Culture and its position within the Eskimo Culture."

Mathiassen has given the name of "Thule Culture" to the old Central Eskimo Culture as represented by the Naujan find. Naujan in Repulse Bay was the first of the sites excavated by the expedition in the summer of 1922. Unlike the usual Eskimo settlements, the house ruins were found at some distance from the sea at an altitude of from 12 to 20 metres above sea-level. As better and more convenient building conditions were found on the sandy slopes nearer the sea, the author points out that "the only possible explanation seems to be that since these houses were built the land had risen considerably. That the land is still rising can clearly be seen by the many raised beaches and strata of marine shells." Other evidence of the gradual rise of the land is given: hence the site must be of considerable antiquity.

The origin of the Thule Culture Mathiassen considers to have been from the west, where greater similarities to it are found than in the east and "from there it has spread eastwards right to Greenland, seeking everywhere to adapt itself to the local geographical conditions" (vol. 2, p. 184). The culture found was maritime, the inhabitants being dependent on the sea for their food and utensils. Fifty-three harpoon heads for seal and walrus hunting were found, and in Part II the author deals with the Thule types of harpoon heads and shows the differences from modern types. That the people were skilful whale hunters as well is shown by the use of whale skulls in the construction of their houses and the large number of baleen objects found.

A most interesting and important discovery was the use in the Thule culture of unbaked pottery. Three small sherds were found at Naujan (Plate 27, 1–3) and a similar sherd at Malerualik. Although the pieces are too small to show the shape and size of the vessels, their presence, as Mathiassen rightly points out, is of great interest, as the use of pottery was quite unknown from the Central and Eastern Eskimo regions: the new discoveries point to a former use as far east as Hudson Bay.

The author quotes Bogoras and Stefansson as to Eskimo methods of making pottery, not after the usual American "Coil" method, but from a lump of clay modelled by hand. This type is called by Wissler in "The American Indian" Mandan-Hidatsa, which is met with in certain parts inland as well as in Alaska and East Siberia. Mathiassen suggests it went into disuse at an early date on account of the plentiful supply of soapstone. The "Women's Boat," unknown among the Central Eskimo proper, was found to have existed in Thule Culture, as a comb (vol. 1, fig. 57) has a scratched drawing of this type of boat with a man with a harpoon and three others with paddles.

There is an interesting account of the recently extinct Sadlermiut collected from the Aivilik Eskimos (vol. 1, pp. 268–287).

The whole book is a mine of information for the study of the material culture of the Eskimo, and the "Concluding Remarks" (vol. 2, pp. 196–201) are an important summary of our knowledge of the origin of the Eskimo culture, wherein the different theories of well-known authorities are described and discussed. This question cannot be settled till much more excavation has taken place on Eskimo sites. The present work, however, has helped enormously, and one looks forward to volumes 4–9 dealing with the ethnology of the Central Eskimo, and 10–12 on the Archæology and Ethnology of the Western Eskimo.

There are 85 excellent plates and over 110 figures, besides several maps.

L. G. C.

ECONOMIC HISTORY OF THE UNITED STATES, presented in Outline. By ROBERT M. MCELROY. Reprinted from Putnam's Historical Atlas. *New York: G. P. Putnam's Sons* 1927. 8×5 *inches;* 86 *pages; with sketch-maps.* 5*s*

The matter in this small book may have served reasonably well as text to maps which supplied other and more specialized information, but in its present form it is distinctly disappointing. To present the economic history of a vast country like the United States even in outline, in such small compass, is an almost impossible task. If any interpretive work of real value is to be done, there must be the severest selection of topics and many gaps must be left. If, on the other hand, an attempt is made to survey the whole field as Professor McElroy has done, the result is apt to amount to little more than an elementary text-book.

The bones of fact in this skeleton are not, however, left quite dry: they have been covered in places with thin flesh of a peculiar sort. The opening sentence gives a key: "The Geography of the Earth must answer the economic problems of its inhabitants," the meaning of which apparently is that throughout the world, and in America in particular, man, consumed with the single passion for material progress, utilizes his environment, and modifies it where unsuitable by means of railway building and so forth, to serve the purposes dictated by this passion; in political matters he follows a ruthless policy of self-interest. In this vein we have abundant references to "economic law" (four, in fact, on one page, p. 10), which is there described as something "which can not be nullified." A similar outlook is maintained throughout. On p. 79 praise is bestowed upon "ruthless progress which awards prosperity to the greatest efficiency," and on p. 80 we read, with reference to the Chicago meat trusts, "the process continued, as ruthless as the former and as beneficent."

To do Americans justice, this insistence upon materialistic motives in interpreting the history of their progress can be overdone. Otherwise, this outline Economic History shows a wide knowledge of the material and a skilful selection, under the difficulties imposed by restriction of space, of the facts required to build up the story in connected sequence; and it furnishes numerous historical data which would show better perspective in a broader setting. E. W. S.

THE AUSTRALIAN BUSH. By MARY E. FULLERTON. *London: J. M. Dent & Sons* 1928. 7×4 *inches;* xvi+242 *pages; illustrations by John C. Goodchild, and a map.* 5*s*

THE NEW ZEALANDERS. By HECTOR BOLITHO. *London: J. M. Dent & Sons* 1928. 7×4 *inches;* xvi+176 *pages; illustrations by Harry Rountree, and a map.* 5*s*

These are the first two volumes of Messrs. Dent's new 'Outward Bound' series, under the general editorship of Mr. Ashley Gibson. The aim of this series is to present "a vivid, accurate, and absolutely up-to-date view of the life under post-war conditions in all parts of the British Empire." It is no easy task to give, within the limits prescribed by these volumes, a comprehensive yet succinct

survey of a country like New Zealand, let alone Australia, in all its phases; yet these books do perform what they set out to perform and their purpose is certainly a laudable one. Miss Fullerton's task is obviously the harder, and she disarms criticism by pleading for mercy where error may have crept in. This must be accorded her, though it may be suggested that a glance at a work of reference would have saved her from an error of 100,000 square miles in the area of Western Australia. Both books touch so many points of interest in the countries with which they are concerned that it is surprising not to find a chapter on modern Australian or New Zealand literature or even a fairly comprehensive bibliography; each book has a bibliography of a sort—yet Miss Fullerton's contains only seven titles (without naming the publishers), Mr. Bolitho's ten (without giving the dates); an even more serious omission is that no index is provided with either work.

O. R.

GREENLAND: Published by the Commission for the Direction of the Geological and Geographical Investigations in Greenland. Editors: M. VAHL, G. C. AMDRUP, L. BOBÉ, A. S. JENSEN. Volume I. The Discovery of Greenland, Exploration and Nature of the Country. *Copenhagen: C. A. Reitzel; London: H. Milford* 1928. 11×7 *inches;* 576 *pages; illustrations and maps*

Few Arctic publications have so well deserved praise as the *Meddelelser om Grønland*, mainly by reason of the high standard of the work which it contains, but also no little because of its excellent appearance and type, and this in spite of slender funds available to the publishing committee. The present work, the first of three volumes, is a separate publication, written in English and guaranteed by the Carlsberg Fund, but with the familiar appearance of the *Meddelelser*. Its intention is to assemble as far as possible the last fifty years' research and progress, and also to take the place of Rink's *Danish Greenland* for those requiring a systematic description of the country. Rink's book was published in 1877, and since then there have been issued no fewer than seventy volumes of the *Meddelelser*. Volume 1 deals with Discovery, Exploration, and Nature of the Country; a second, to be published before Christmas, will deal with Past and Present Population; and the concluding volume on Colonization and History will appear in 1929. One can say at once that the publication fulfils in every way the wishes of its sponsors, and constitutes a book indispensable both to those already interested in Greenland and to any seeking the most up-to-date and reliable information. There are abundant text-illustrations and maps, and no pains seem to have been spared to make it as complete and as satisfactory as possible.

Historical articles by Dr. Bobé and Admiral Wandel cover the period from the middle of the fifteenth century (when contact with the early Norse settlements was broken off) down to the scientific expeditions of the present generation. In this way the ground is prepared for more technical articles such as those on the geology by Prof. Böggild, the botany by Prof. Ostenfeld, and the fauna by Prof. Jensen. A chapter on the Waters round Greenland by Dr. Nielsen supplies bathymetrical and hydrographical details not otherwise easy to trace to the original publications. Physiographic accounts of the various regions have been written by Dr. Birket-Smith, Dr. Lauge Koch, and Dr. Storgaard, that by Koch incorporating much new material. Finally, one may mention the chapter on cartography which partly includes, and supplements, Björnbo's 'Cartographia Groenlandica,' published in Danish in 1912. Each of the articles is supplied by a Danish expert in his subject: not the less noticeable, therefore, is the appreciation shown for work accomplished in Greenland by other nationalities. the comprehensive yet critical attitude adopted throughout, and a general balance and proportion not always found in composite works of this nature.

J. M. W.

SKRIFTER OM SVALBARD OG NORDISHAVET. Resultater av de Norske Statsunderstøttede Spitsbergenekspeditioner. Nos. 2–12. *Oslo* 1922–1927

A special periodical devoted to Spitsbergen has long been necessary; it is a pleasure therefore to welcome these eleven numbers of a Norwegian enterprise comparable to the Danish publications on Greenland. The series, apparently subsidized by State grants, is issued from Det Norske Videnskaps-Akademi in Oslo, and edited by Dr. Adolf Hoel. It may be noted that the present subtitle appeared as the main title in the earlier numbers, but was superseded in 1927 by the more comprehensive and shorter *Skrifter om Svalbard*. At the same time the original attempt to group the articles in volumes has been dropped, and each paper will now be numbered consecutively as it appears. No. 1 is still in preparation, and will comprise a review of all the Norwegian expeditions in the north from 1906 to 1926.

The various papers are with one exception written in English. Some of the shorter ones are biological, but taken throughout those with a geological bearing are in the majority. In this connection No. 12 on "The Downtonian and Devonian Vertebrates," by Prof. Stensiö of Stockholm, with over 100 full-page plates, is likely to be of outstanding importance to all palæontologists. Two of the most interesting papers are No. 6 on "The Coal Deposits and Coal Mining," by Dr. Hoel, and No. 10 on " Hopen (Hope Island)" by Captain Thor Iversen. The latter gives a full account of an expedition in 1924, which landed and made a preliminary survey of this somewhat elusive island. The position on the chart is now definitely fixed, and also the rather unusual shape, not unlike a walking stick. On p. 7 the various chart-wanderings and transformations of shape are shown in an interesting way; it appears that the most accurate of the older charts was that of Wm. Scoresby, who in 1820 set down both the shape and the size very accurately, but was less fortunate in his determination of longitude. The paper on Hope Island is selected for particular mention, but it should be added that all the papers in the series have their special interest. Well supplied with both illustrations and maps, the numbers so far issued make it evident that this is already a periodical of importance and will do full justice to the widespread activities of Norway in the investigation and development of Svalbard. J. M. W.

DER BEWEGUNGSMECHANISMUS DER ERDE: dargelegt am Bau der irdischen Gebirgssysteme. By Dr. RUDOLF STAUB. *Berlin: Gebrüder Borntraeger* 1928. 10×7 *inches;* viii+270 *pages; maps and diagrams. M.*18

The fact that the major features of the Earth fall into some sort of rough pattern has made the temptation to premature speculation on a simple scheme of causation always a strong one: and now that the theory of isostasy appears to permit the speculator to move the land masses freely over the globe like pawns on a chessboard, this temptation has become to many overwhelming. Dr. Staub, writing in his well-known eager, almost impassioned style, offers a solution that is novel in several respects. Briefly, three crustal units are concerned: the Pacific floor, Laurasia (the northern land-mass), and Gondwana (the southern land-mass). The first plays an entirely passive rôle; the two latter, urged equatorwards by centrifugal force, are pressed one against the other and against the Pacific block, whence the fold-mountains arise. The towering up of a mountain system, producing local overloading, causes the underlying magma to "stream" polewards; it drags with it the superincumbent crust, so that a new geosyncline is opened, which in the next cycle will be closed again. A very minor rôle is assigned to westerly drift, and Staub also parts fron Wegener in

regarding both the Atlantic and Indian Oceans as regions of "in-break." The unique character of the Pacific Floor he attributes to an overflowing of heavy, deep-seated magma on the occasion of the birth of the Moon.

The use of a cylindrical projection for the illustrative maps is unfortunate, since it glosses over a difficulty. The equatorial movement of a land-mass on a cylindrical earth would have a very different result from that of a land-mass on a globe, where meridional splitting would be expected.

Such speculations as those of Wegener and Staub have a value as provoking thought, and as adding stimulus to the laborious collection and sifting of observations, but in themselves they can only command respect when accompanied by a mathematical analysis of the forces involved. Are centrifugal force and subcrustal flow adequate to the stupendous task which Dr. Staub imposes upon them?

In the long and comprehensive list of authorities consulted, the author omits, strangely enough, the name of Prof. Joly. Nor does he consider the function of either earth-shrinkage or radio-activity in relation to the mechanism of mountain-building. E. G. R. T.

THE THIRSTY EARTH: A Study in Irrigation. By E. H. CARRIER, M.A. *London: Christophers* 1928. 9×6 *inches;* viii+214 *pages; and illustrations.* 10*s* 6*d*

This book belongs to a class perhaps too infrequently represented in our geographical literature, since it is a review—as distinct from a technical treatise—of a selected branch of economic activity which possesses intrinsic geographical and social interest. A work of this description, well executed, has obviously considerable value, and Miss Carrier deserves well of those "students of Geography and History" for whom in particular she has attempted her task.

The survey of irrigation as practised in ancient and modern times in the Old and New Worlds (Parts II, III, IV) is introduced by a section (Part I) upon the general geographical principles implied, and is concluded by a brief note which closes with what is almost a pæan. In Parts II, III, IV some attention is paid to the special geographical factors involved in the various cases dealt with; the historical aspects (expansion and increasing legal organization of irrigation systems) are often noted, and figures—some of them out of date—indicate orders of economic importance. The selection of instances reviewed is comprehensive and these sections should prove useful to students, the more so as they include a good deal of "class-room" geography. Appended to each chapter, as to the book as a whole, is a bibliography, in which however one misses references to several recent and more specialized sources.

In a book of such ambitious scope brevity and summary treatment are inevitable, but this would hardly seem to justify the vagueness and misleading nature of some passages. Perhaps, for instance, an innocent reader should not be left with such notions as that the Sahara, a "desert of shifting sand," abounds in underground rivers; that the source of the winter rainfall of the Punjab and the monsoonal rainfall of Abyssinia can be definitely localized, and that "The activities of the Medes, Persians, and Greeks, culminating in the adventures of Alexander, may likewise be explained as the more or less direct consequences of the movements of people due to the hunger urge." Such statements are perhaps due to incaution, and a careful revision of Part I in particular, and of the beographical groundwork in general, would eliminate them. Despite these blemishes, the book will undoubtedly prove its value as an introduction to an interesting and difficult subject. O. H. T. R.

CHRISTOPHE COLOMB VU PAR UN MARIN. By J. B. CHARCOT. *Paris: Ernest Flammarion* 1928. 10×7 *inches;* 320 *pages; maps and illustrations. Francs* 30

The famous leader of the *Pourquoi Pas?* expedition of 1908–10 describes his work on Columbus as "Destiné à 'l'homme de la rue,' et surtout aux jeunes," and adds "il fut écrit avec passion." It bears, indeed, the stamp of passionate hero-worship, and to Jean Charcot, the critical work of Henri Vignaud and others is an "attack," an unworthy attempt to blacken the reputation of the great admiral. The writer makes, however, no pretensions to scholarship, but the general reader will find the book delightful. He will appreciate especially the excellent maps and illustrations, and also the sections on the types of ships of the fifteenth century, on the early mariners' compass and other nautical instruments, on the magnetic declination, on the winds, currents, and storms of the seas traversed during the Four Voyages, and on other matters of which Charcot can write as himself a great seafarer. Such matters receive, perhaps, insufficient attention from the scholar, who will find the present work valuable, not because it tells him anything new, or is even free from error, but because it affords him an insight into the seaman's attitude of mind and scale of values, and recalls him to the fact that in the elucidation of past history the study of documents alone is insufficient: the mentality of the actors, and the geographical setting of their actions, are alike of first importance. E. G. R. T.

TESTO E ATLANTE DI GEOGRAFIA ECCLESIASTICA E MISSIONARIA. By LUIGI GRAMATICA. *Bergamo: Istituto Italiana d'Arte Grafiche* 1927. 13×10 *inches;* 32 *maps.* 130 *Lire*

Some years ago (1923) we had occasion to review in this *Journal* a striking work on 'The Christian Occupation of China,' in which the history and progress of the movement, in its religious, educational, and philanthropic aspects, were clearly sketched, while the value of the interesting text was enhanced by an excellent series of maps. But the volume lacked completeness in the fact that comparatively little reliable and authentic information was found possible of inclusion regarding the historic activities and modern progress of the work of the Missions of the Roman Catholic Church.

In the interesting and important work now before us, however, this deficiency is in great part made good, although the extent of the field makes it inevitable that the space allotted to any one country is somewhat restricted. The maps, of which there are thirty-two, are well printed, and the descriptive and explanatory text is of great interest. Taken together they serve to illustrate the world-wide scope of the missionary labours of the Roman Communion to a degree which will probably come as a surprise to many readers.

In the map of Japan, with its five dioceses, we have significant reminders of the romantic and tragic vicissitudes through which the "Christian Occupation" of Japan passed in the sixteenth and seventeenth centuries, from the lonely figure of Francis Xavier on his early evangelistic journey from Kiushiu to Kyoto, to the hundreds of thousands in Southern and Central Japan who were called by the Christian name, and finally to the scattered bands of exiled believers, survivors of the prolonged and ruthless persecution which reached its climax in the middle of the seventeenth century. The closing of the country to intercourse with most of the outside world, which continued in force for 200 years, had a curious sequel. When Japan was once more, under compulsion, opened to traffic with the West, some of the earlier visitors to the southern island of Kiushiu found settled in a secluded valley in the region of Nagasaki a community living apart from their fellows and maintaining traditions of Christian worship

as handed down through the generations that had passed since the days when their forefathers had witnessed for that Faith in such troublous times. It is no mere coincidence that in this region alone the figures for the Roman Christian adherents now amount to over two-thirds of the total numbers for the whole country, *i.e.* 62,000 out of 89,000. This latter figure is of unusual interest as giving authoritative declaration on a point as to which the members of other Communions have hitherto had little or no definite and detailed information.

Altogether the atlas deserves high praise, and the explanatory matter is fully worthy of the clearly drawn maps which it is intended to supplement and to explain. W. W.

STANDING ROOM ONLY? By EDWARD A. ROSS. *London: Chapman & Hall* 1928. 8×6 *inches;* xvi+368 *pages; diagrams.* 16*s*

This is not the place to discuss the fundamental idea of this book, the nature of which is sufficiently indicated by the title, apparently taken from Clark Wissler's 'Man and Culture,' since it occurs in a paragraph quoted from that book on pp. 24–25. It is taken for granted that there is a universal menace of redundant population unless the tendencies in that direction are successfully met by human reason and human will. Naturally this underlying conception leads to sundry observations of geographical interest. One of these (p. 344) declaring that "until the Asiatic thinkers wake up to the population tendencies in the world to-day and perceive the folly of curbing famine and pestilence without at the same time delaying marriage or restricting births they must expect that in sheer self defence the Western peoples will meet the menace of a deluge of Asiatics by throwing up barriers" is apt to read at first somewhat startlingly; but it is only fair to the author to correct the impression of apparent ruthlessness which might be produced by this statement by referring to the author's pæan on p. 46 on man's rapid conquest of disease in a fight now world-wide (p. 65). Two striking statements of the author under the head of the Growth of Population may be noted. The English-speaking whites of the world have, he tells us, increased nearly eightfold since 1800, and now form more than one-fourth of the population of European descent as against less than one-eighth at the earlier date (p. 91). The other statement that in the sixty years 1860–1920 the population of tropical colonies and dependencies of the great nations has increased by 105 millions, "a chance by-product, so to speak, of capitalistic industry in the tropics" (pp. 93–4), has perhaps a more direct bearing on the main subject of the book, especially when taken in association with reflections contained in the following chapter under the head of "Prospects of the Food Supply" (pp. 111–112). There, after adopting from an article by C. F. Marbut and C. B. Manifold in the *Geographical Review*, July 1926 (p. 442) the view that soil and climate were to be counted as constituting only one of the factors favouring the rapid agricultural development of the United States, Russia, and Argentina, requiring as the other factor a correspondingly rapid industrial development in Europe and America—a concurrence not likely to exist again for a considerable time to come—he notes that less and less are the tropical populations, in Jamaica, Cuba, the Philippines, Java, etc., living on what they raise, but are compelled to import ever-increasing quantities of food.

G. G. C.

THE MONTHLY RECORD

SURVEY IN FRENCH WEST AFRICA

A short account of the work of the *Service Géographique* of French West Africa since the war is given by Comm. Ed. de Martonne, the Chief of the Service, in the *Bulletin* of the Comitè d'Etudes historiques et scientifiques de l'A.O.F. Until 1923, reorganization, classification of records, etc., claimed attention. From the recommencement of field work, the *Service* has been hampered by the smallness of the personnel. Field work was begun with three officers: in 1927, after having reached 14, the number stood at 10. This necessitated arduous tours of duty which affected the health of the officials. From three to five draughtsmen were maintained at Dakar. All maps were sent to France for reproduction. In spite of these difficulties, a considerable advance has been made in the cartography of West Africa. Between 1924 and 1927, 206 positions had been determined astronomically by the aid of wireless, mainly in the Côte d'Ivorie, Haut Volta, and the Southern Sudan, and 140 magnetic stations occupied. In French Guinea during the same period, meridian and parallel first-order chains linking the primary triangulation of Guinea with that of Senegal were executed, and in addition a certain amount of supplementary work. Further details of the geodetic and astronomical work are given in the Report presented to the International Geodetic Union at Praha in 1927. Little progress has yet been made with levelling. Before the reorganization of the *Service* work had been done for 20 sheets on the scale of 1/200,000; of these 8 only were complete, mainly in Guinea and Senegal. Nineteen sheets on the scale of 1/100,000 had been published. The first task was to complete the unfinished sheets: this occupied the three or four topographers available for five years, during which 51,750 km.^{2} were surveyed, half lying in the mountainous region of Guinea. By the end of 1927, 17 sheets of the 1/200,000 map had been published, and 4 were in the press. The *Service Geographique* was also represented on the various boundary demarcation commissions on the French frontiers, and valuable material secured. As the completion of the 1/200,000 map must necessarily be delayed for many years, a "semi-regular" topographical map is being produced, that is, all routes and principal tracks are shown accurately, but no attempt is made to cover all the ground. This work was begun in 1924 in the Côte d'Ivoire, Haute-Volta, and the Sudan: 206 astronomical positions have been fixed and 21,650 kilometres of routes surveyed: 35 sheets on the scale of 1/200,000 embodying these results have been issued; 40 more will complete this series.

While in the field, officers are charged with the compilation of statistical and administrative information, which is preserved at Dakar. In summing up the present position, Comm. Ed. de Martonne points out that 5 per cent. of the area of the colonies has been surveyed on a framework of geodetic triangulation, about 20 per cent. is covered by the "semi-regular" topographical survey based upon astronomically determined points, about 65 per cent. by reconnaissance (inferior astronomical determinations) and exploratory survey, the remaining 10 per cent. approximately being practically unknown country.

ROADS IN FRENCH WEST AFRICA

The great development of the road system in the separate colonies of French West Africa, which has taken place since the war, is clearly shown in a summary of the position early in the present year, by Albert Rovagny, printed in the *Renseignements Coloniaux* of the Comité de l'Afrique Française, No. 4, 1928. So much has been done in this direction that the old slow method of travel by means of beasts of burden or human porters is now a thing of the past, and none

of the colonies is without its network of roads, though French Guinea, by reason of its broken relief, is less well provided than the others. Here, as well as in Senegal, the Ivory Coast, and Dahomey, a railway serves as the central artery, but in so vast a territory the extension of railways on any large scale is out of the question, and recourse must be had to roads as feeders to the former, and for local communications. The total now available for motor transport of one kind or another now reaches the high figure of 34,000 km., of which 5000 falls to Senegal, 6000 to the Ivory Coast, over 9000 to the French Sudan, and over 10,000 to the Upper Volta, which is not yet provided with a railway. The roads are divided into different categories, some being usable throughout the year and some in the dry season only, and their condition varies greatly, though for economic reasons only a small proportion are fully metalled, the rest making use largely of the natural surface with some coating of laterite, or in some cases only of the soil of anthills, or of sea-shells. The article gives details of the main and secondary roads of each colony, the general network of the former being shown in a sketch-map. Their routes have been chosen not only in reference to the needs of the individual colonies, but to supply communication between them or across the whole territory. Thus the 4000 km. from Dakar to Lake Chad can be traversed in about ten days, two-thirds of the distance being done by motor. Timbuktu has already a continuous connection with Say on the Middle Niger, by a road following the course of the river, and a project is on foot for a road to connect it with the existing network at Mopti on the upper river. This extensive system of roads is bound to have a beneficial effect on the commercial development of the territory, as in the African possessions of other Powers.

DISASTER TO CANADIAN EXPLORERS

It is reported from the Canadian Government post at Chesterfield Inlet that the bodies of Mr. John Hornby, the Canadian explorer, and two companions have been found. Mr. Hornby was engaged in examining the country north of the Great Slave Lake. His companions, Mr. Edgar Christian and Mr. Harold Adlard, left Edmonton in 1926 and travelled mostly by canoe to Fort Resolution, where the three set out for the north-eastern arm of the lake, planning eventually to reach the northern coast. It was their intention to live on the country, building a hut for the winters. Until the report that their bodies had been found starved to death in a cabin at the junction of Thelon and Hanbury rivers, 300 miles west of Chesterfield Inlet, no news had been received for over two years. Mr. Hornby had spent twenty years in North-West Canada prospecting, hunting, and collecting for the Canadian Government. He was an authority on the caribou, and had devised a scheme for herding them as reindeer are. He was also well acquainted with the Eskimo way of life. At the time of his death he was fifty-one years of age.

EXPLORATION OF WESTERN CANADA

Two hitherto obscure points in the exploration of Western Canada have been cleared up in recent publications: the route followed by Henry Kelsey on his journey from York Factory, Hudson Bay, in 1691–2; and the leader of the expedition along the Finlay River in 1824. The first is dealt with by Dr. C. N. Bell in the *Transactions* (No. 4) of the Historical and Scientific Society of Manitoba. The basis of the pamphlet is a number of Kelsey's papers and journal which have recently been deposited in the Record Office of Northern Ireland. The only source of information previously known was his journal, submitted to a Committee of the House of Commons in 1749, which was too vague to establish his route accurately. From his knowledge of local conditions, the additional facts in

the new journal and the accounts of later explorers, especially Anthony Hendry, Dr. Bell traces out Kelsey's itinerary. His object was to induce the Indians of the West to send furs to York Factory. The main journey began from "Deerings Point," 600 miles south-west of York Factory, and located by Dr. Bell on a neck of land between Lake Winnipegosis and Cedar Lake. Accompanied by Indians, Kelsey travelled by canoe 43 miles up the Saskatchewan River, and then 28 miles up Carrots River, where the canoes were abandoned. He then proceeded on foot into the "country of the Assiniboines." Dr. Bell shows that he probably crossed first muskeg country and then more open prairie to the Red Deer River, and then, ascending it, reached the Great Salt Plain, which he crossed to the Touchwood Hills. On this plain the party encountered "great store of Buffilo, but killed none," and later "a great sort of a bear wch is bigger than any White Bear, and is neither white nor black:" thus it is claimed for Kelsey that he was the first white man to see the buffalo and the grizzly bear of the Canadian prairie. He describes in detail the hunting methods of the Indians, and the customs and habits of the Assiniboine and Cree tribes. Dr. Bell also publishes an account of a previous journey by Kelsey, to the country north of the Churchill River in 1689. The pamphlet is well furnished with facsimile reproductions of contemporary maps.

The second incident is dealt with by Mr. J. N. Wallace in the *Canadian Historical Review*, March 1928. The leader of an expedition along the Finlay branch of the Peace River in 1824 is generally stated by historians to have been a John Finlay. Dr. Bryce ('History of the Hudson's Bay Company') quotes extracts from a MS. journal of the expedition, which was certified by Chief Factor J. McDougall to be the work of Finlay. Other writers have added small details, such as that he was in the service of the Hudson Bay Company, and identified this Finlay with another Finlay who had built a post on Peace River in 1792 for Alexander Mackenzie, though it is improbable that he could have been active in travel thirty-two years later, nor was any man of that name serving the Company in the West at that time. Dr. Bryce, quoting the journal, gives the composition of the party as "six canoe-men, M. McDonald, Manson, and myself." When examining some records at Fort Chipewyan recently, Mr. Wallace noticed that in a pay list for 1824, the words "R.M.Expedtn." appeared opposite several names. Assuming this to represent "Rocky Mountain Expedition," he found that these names corresponded with the names of the party given by Dr. Bryce, except that John Finlay did not appear, his place being taken by "Samuel Black, C. Trader," and the two names "M. McDonald, Manson" become Mr. Donald Manson. Thus it appears that the attribution of the leadership of the 1824 expedition to a John Finlay arose from a confusion, and that the actual leader was Samuel Black. Black, who was probably born between 1785 and 1790, had had an adventurous career in the North-West Company at the time of its great rivalry with the Hudson Bay Company. At Lake Ile à la Crosse, 3 miles west of Beaver River, there are remains of a fort to which tradition gives his name. On the amalgamation of the two Companies in 1821 Black became a chief trader. After his exploration of the Finlay river Black crossed the Rocky Mountains, and was chief factor at Kamloops, where he was killed by an Indian in 1841.

THE WILKINS AND BYRD ANTARCTIC EXPEDITIONS

Sir Hubert Wilkins is engaged upon a rapidly planned aeroplane expedition in the Antarctic. He left Montevideo, where his party had been guests of the Uruguayan Government, on October 22 by the Norwegian whaler *Hectoria* for Deception Island, South Shetlands. With him are Lieut. C. B. Eielson who

accompanied him on his flight from Alaska to Spitsbergen earlier in the year, another pilot, and two mechanics. They have with them two Lockheed-Vega seaplanes. Sir Hubert intends to establish his main base on Deception Island, with an advanced base 500 miles to the south, probably on the Weddell Sea coast of Graham Land. From this base he proposes to make flights in various directions for photography and survey. Finally he will fly along the Ross Quadrant coast to the Ross Sea, a route which will take him across a little-known region. From photographs and other information he hopes to be able to select sites for proposed meteorological stations—the main purpose of the expedition. He had originally intended to make this flight in the opposite direction, that is, from the Ross Sea, hoping to reach one of the numerous whalers at work off the South Shetlands. As at present planned, he will reach the Ross Sea while Commander Byrd is working there. An account of the latter's plans for an expedition on a much larger scale was given in the *Journal* for January last. These expeditions are not competing against each other: the leaders hope to cooperate in the Ross Sea area, and Sir Hubert does not contemplate flying to the South Pole. Commander Byrd left Boston on October 2 to join the whaler *Larsen* at San Pedro, California. The four ships of the expedition will assemble at Dunedin before making for the Bay of Whales. Commander Byrd hopes to return by July 1930.

A NEW TYPE OF POLAR CHART

We have received from the *Bureau Hydrographique International* a pamphlet by Captain L. Tonta (reprinted from *La Revue Hydrographique*, No. 10, 1928) proposing a new type of Polar chart. If one constructs a Mercator Projection with the North Magnetic Pole as pole and the geographical meridian through it as the central meridian, the north polar basin is included between the "paramagnetic" meridians 90° E. and 45° W., and parallels 45° and 83° N.; and after consideration of the figure representing lines of force and curves of equal magnetic declination in the neighbourhood of the north pole, from the paper by Mr. H. Spencer Jones published in the *Journal* for December 1923, Captain Tonta concludes that the curves of equal "paramagnetic" declination will be relatively simple and will not deviate greatly from the paramagnetic meridians. He does not, however, construct them. After discussing alternative poles for the projection, he finally recommends a pole on the equator: in fact, the transverse Mercator with central meridian 96° W. The distortions within the Arctic basin are then slight. But we should like to see the lines of equal "fictitious" declination drawn, before expressing an opinion on the merits of the proposal.

DEEP-SEA SOUNDINGS IN THE PACIFIC

The German cruiser *Emden* reported last year that on April 29 she had obtained a sounding of 10,793 metres in the Philippine Deep. This was the first time that an ocean depth greater than 10,000 metres had been recorded. As it was obtained by echo-sounding apparatus some doubts of its accuracy might have been felt; accordingly, after the return of the vessel, Herr H. Maurer has published in the *Geographische Zeitschrift*, Nr. 5/6, 1928, an examination of the figures. In the calculation of the velocity of sound at various depths tables issued by the U.S. Coast and Geodetic Service were employed, but he points out that if the tables since issued by the Hydrographic Department of the Admiralty had been used, the results between 8000 and 10,000 metres would be greater by from 30–40 metres. As to the accuracy of the observations: at these great depths a stop-watch had to be used in place of the mechanical time apparatus. Experiments were therefore carried out to ascertain the error thus introduced, and it was found that the stop-watch gave results probably about

150–180 metres too great. Allowing for this, forty results give a depth of over 10,000 metres; these soundings lie together roughly in a rectangle within which only five depths of less than 10,000 metres were recorded, while in the surrounding area one depth only of over 10,000 metres was obtained. The position of these deep soundings is approximately 126° 50′ E., 9° 41′ N. A chart showing the course of the *Emden* and the soundings accompanies the paper.

STUDY OF ANCIENT GEOGRAPHY

For the subject of his Presidential Address to Section E at the Glasgow Meeting of the British Association this year, Prof. J. L. Myres selected "Ancient Geography in Modern Education." This summary of many years' experience was prompted by two considerations, the opening of a "New Phase in Education" which will necessitate the reorganization of studies for pupils over eleven years of age, and the reflection that where "ancient history holds the most honoured and responsible place, that indifference to geographical considerations has lasted longest and most generally." In his demonstration of the reasonable place due to ancient geography in the educational system, Prof. Myers starts with the complementary nature of historical and geographical studies which he has continuously and forcibly urged—the central consideration that every geographical fact has its historical aspect, and every historical fact its geographical aspect, and the further consideration, that human geography contemplates not facts alone, but events with causes and effects, for example, the historical duration of a glacier closing a pass, the geographical distribution of city states or Parliamentary institutions. The human sciences and the natural sciences permit both of historical and of distributional treatment, the latter being ubiquitous and inextricable.

Having established the interdependence of history and geography, Prof. Myres proceeds to discuss the practical and useful aims of education, comprised in the training in citizenship, the analytical presentation of "the pageant of external nature" and the methods by which its processes are applied in man's service, and, finally, the cultivation of faculties of observation of, and inference from, actual surroundings. The latter aim is best achieved in regional studies, as is generally realized. The study of a district undergoing "modern improvement" inevitably leads to comparison with its circumstances as "unspoilt country," and ultimately to conditions at the dawn of history. This inquiry into the homeland and its part in shaping careers and outlook is the function of ancient geography in modern education. But the appreciation of our civilization cannot be complete without an understanding of that of Greece, Rome, or Israel, In the Ægean, moreover, the relations of life to the physical conditions of the Archipelago were especially strict. These conditions have been, in the main, stable. As a record of long-continued human occupation, the history of this region has also special value: the coordination of classical history and regional study of the Mediterranean is therefore essential. The Ancient East, too, has its individual attractions. The Authorized Version of the Old Testament yields its full value only when it is regarded as great literature, history, and geography—it is "an autobiography of an immigrant people during the whole momentous process of acclimatization to regional conditions strongly contrasted with those out of which the new-comers came." Later, it records the repercussion on two small Palestinian states of the great civilizations of the East. This correlation in classical teaching, Prof. Myres considers from his experience of examinations, will be regarded to-day as "something of a revolution": he instances the poor standard of illustrative sketch-maps, due to failure to conceive regional matters in a form expressible by geographical symbols, to regard a finished map as a

scientific instrument and a work of art. This separation of the humanities from geography can be explained on political and social grounds, but the reaction against it may be traced from the end of the eighteenth century. The suggestions in the address require no overloading of the syllabus with new subjects, but simply coordination and adjustment between teachers, and a point of view.

COOK EXHIBITION AT THE RECORD OFFICE

To commemorate the bi-centenary of Capt. James Cook's birth, a selection from the voluminous Admiralty documents is being shown at the Public Record Office Museum. The exhibits cover the four main stages of his career, and have been chosen partly for their historical interest and partly to illustrate the classes of documents preserved in the Admiralty archives. The first item is the Muster of H.M.S. *Eagle*, 1755–6, in which Cook is entered as a volunteer on 17 June 1755, his first appearance in the Royal Navy. His first voyage to the South Seas, for the primary purpose of observing the Transit of Venus, and on which the eastern coast of Australia was discovered and surveyed, is represented by the volume of secret instructions from the Admiralty, the Master's log of the *Endeavour* from 26 August 1768 to 20 October 1769, and two holograph letters. The first of these is an application to the Admiralty for mathematical instruments and stationery dated 8 July 1768; the second is an application for three weeks' leave in December 1771 to visit his aged father in Yorkshire, which was apparently granted. It may be mentioned here that the Exhibition of Charts and Maps on view at the Science Museum, South Kensington, contains several examples of Cook's work. There are two charts drawn while he was acquiring that knowledge of hydrographical surveying which he employed so profitably later, a chart of Fowey Harbour, one of the Islands of St. Peter, Langly and Miquelong, done in 1763 for the Governor of Newfoundland, and one of the "Straights of Bellisle," 1760. The Australian charts include his original plan of Botany Bay, 1 inch to 0·67 mile, a chart of the coast-line of East Australia, and another of New Zealand. Cook's second voyage, 1771–75, is illustrated in the Record Office exhibition by the Journal of the *Resolution* from 13 July 1772 to 21 March 1775, open at the part dealing with Easter Island. This Journal originally contained many maps and illustrations; these are now preserved separately. For his third voyage, 1776–80, are shown a chart of part of the North-West Coast of America, which was enclosed in his last letter to the Admiralty, and a drawing of Karakakoa Bay, Hawaii, where Cook was killed.

THE NAVIGATOR ALVISE DA MOSTO

This Venetian navigator gained fame above all for his voyages of exploration on the West Coast of Africa under the auspices of Prince Henry the Navigator, an account of which, written by himself, has been preserved. Little has been known generally about his family and the other events of his life apart from the few details given by him at the beginning of the narrative of his voyages. Persevering researches in the Venetian and other Italian archives by Signor A. Da Mosto, presumably a member of the same Venetian family, have however resulted in bringing together a considerable body of facts about his ancestry, his more immediate family, and the part which he played in the history, external as well as internal, of his country. They have recently been published in the *Archivio Veneto* (vol. 2, 1927), in which an outline of the main facts elicited is followed by the text of the documents, sixty in all, from which they have been ascertained. The family was unknown in Venice till the thirteenth century, when it seems to have migrated thither, from Lodi according to the most probable account. From 1297 on the family was numbered among the Patrician families of Venice, afterwards splitting up into various branches.

Signor Da Mosto has been able to establish the genealogical tree of the branch known as that of the Holy Apostles (from the palace which it owned in Venice) from the late thirteenth century to after the navigator's time. The latter's father, Giovanni, was a man of substance and importance, but of an avaricious nature, and became involved in lawsuits, eventually falling into disgrace and being banished from his native city in 1453. To repair the disorder in the family affairs was no doubt one of the motives which led the eldest son, Alvise, to embark in foreign enterprises. He had already made voyages to Alexandria and to Flanders when in 1454 he set out with his brother Antonio on a commercial voyage to England and Flanders. But during a detention in Portugal he learnt enough of the African enterprises of Prince Henry to become inflamed with ardour for discovery. Gaining the prince's favour, he left his brother to continue the commercial venture alone, and made his two well-known African voyages in 1455 and 1456, discovering the Cape Verde Group in the latter year in association with Antonietto Usodimari. This seems to have satisfied his ambition in that direction, and he remained in Portugal, for the most part engaged in commerce, until February 1463–64. During this period he wrote the account of his own voyages as well as of Pedro de Cintra's (1462) and possibly also constructed the Portolano attributed to him. Unfortunately none of the documents brought to light supplies new information on the African voyages.

Returning to Venice after ten years' absence Alvise occupied himself with commerce, with the administration of the family property, and with the public life of the city, in which he took a high position. He also did important work for his country in connection with the war with the Turks then raging, being appointed (among other charges) Venetian administrator at Coron, regarded as one of the keys of the Morea. In 1481 he commanded a Venetian armed squadron sent for commercial objects to Alexandria, and in 1483 was given an important administrative post in connection with the military operations against the Duke of Ferrara. While engaged in this task he died in the full vigour of manhood, leaving no issue, his marriage in 1466 having been unfruitful.

It is pointed out that the form "Cadamosto" often given to the navigator's name is inaccurate, the full name being strictly Alvise da ca' Da Mosto.

TRAVEL IN TURKEY

Regarding the review of Herr Richard Hartmann's book, 'Im Neuen Anatolien,' published in the August *Journal* (71, 168), Mr. W. E. D. Allen writes that the unfavourable reflections on conditions of travel in Turkey contained in it are not supported by his experiences during the spring and summer of this year. He has not read Hartmann's book, but he thinks that the review might discourage intending travellers in Turkey. Though his way lay mostly off the railways, his impression was that the trains were clean and punctual. The country hotels and inns were also clean: to some extent this must of course depend upon the innkeeper, but Mr. Allen, in places as widely distributed as Kaisaria, Sivas, Trebizond, Baiburt, Riza, and Borchka, found the hotels scrupulously clean. He cannot believe that hotels in the railway towns can be inferior to those of Central and Eastern Anatolia. Food is, of course, indifferent by European standards, but good bread, eggs, fruit, vegetable soup, yaourt, *douriko*, and coffee can be obtained almost everywhere, and should not be expensive. Police regulations in most districts are a mere formality. The country east of the Euphrates and south of the Chorokh is a military zone closed to foreigners, but elsewhere movement is as free as in many countries of Eastern Europe. The standard of courtesy, discipline, and honesty among the Turkish police is excellent. Mr. Allen concludes by advising the prospective traveller to secure the services of a dragoman,

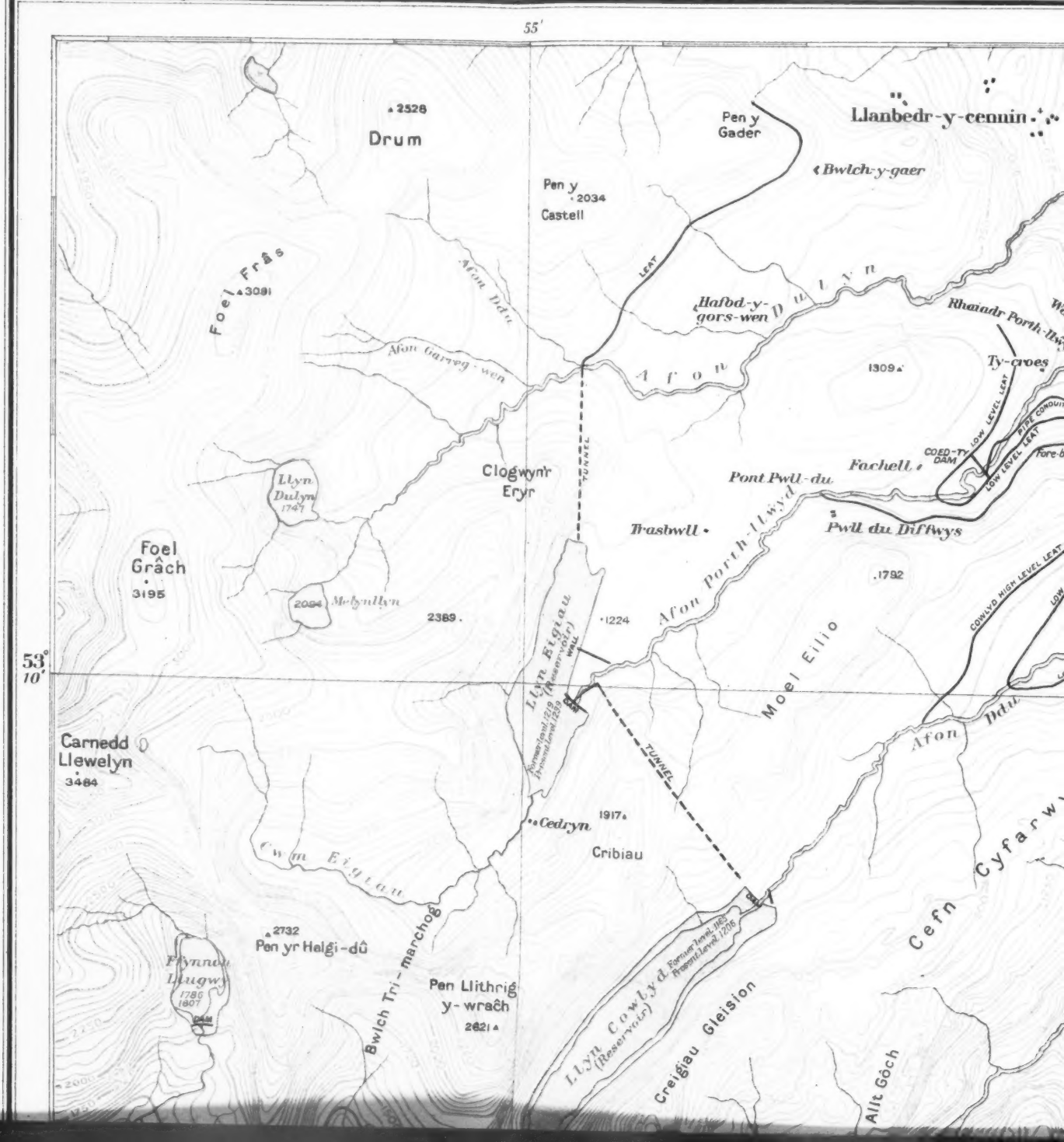
for the latter will effect economies in hotel and other charges, and smooth the path of the traveller in many directions. He found the Turk still inclined to be suspicious of foreigners, though much less so than five, or even two, years ago, and he thinks it unfortunate that any one should be deterred, by exaggeration of the difficulties of travel, from visiting Turkey—a country it is very necessary should be known and understood here.

MOSQUITO CONTROL

We have received from the British Mosquito Control Institute a pamphlet describing its organization and work, with the Report submitted at the second annual meeting. The Institute originated in an anti-mosquito campaign on Hayling Island in 1920. Later the Director, Mr. J. F. Marshall, in order to extend the scope of the work, erected an adequately equipped building at his own expense, and secured the cooperation of a number of scientists. In 1927 the Institute was incorporated for "the furtherance of experimental, educational and research work in connection with mosquitoes and other noxious insects, particularly with a view to advising upon and undertaking the practical measures required to control them." On Hayling Island a control scheme covering 6 square miles has been in operation for eight years. All stagnant water is inspected, the larvæ collected, details of the salinity, etc., of the water, nature of the vegetation, and other relevant information recorded, the breeding-places destroyed by oil or by drainage, and the occurrences marked on a large-scale map. The Institute building is equipped to deal with research. Advisory work is also carried on, correspondence dealt with, specimens and literature despatched, and visits of the Director arranged to particular localities. A register of specimens contains at present the details and life-history of 3500 batches of British mosquitoes, a valuable record previously entirely wanting. The educational side is also being developed, by the preparation of slides, photographs, and mounted specimens. A handbook, 'Principles and practice of mosquito control,' has been issued. For medical officers and others interested short instructional courses have been arranged. Further details of the work can be obtained from the Director, British Mosquito Control Institute, Hayling Island, Hants.

PART OF NORTH WALES

To illustrate the paper on "A Topographical Study of the Flood-swep
above Dolgarrog" by Prof. W. G. Fearnsides, M.A., F.G.S. and W.H.



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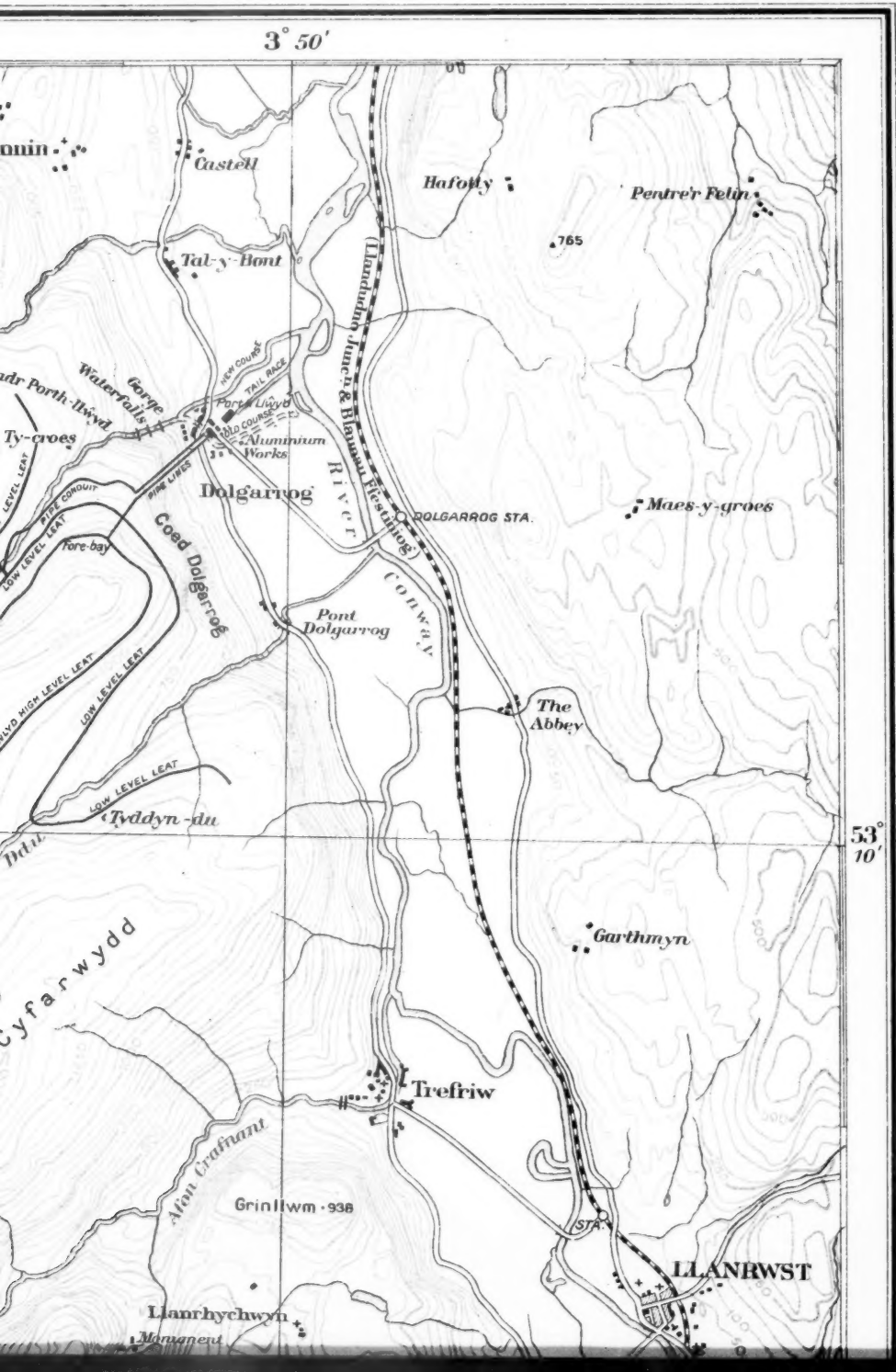
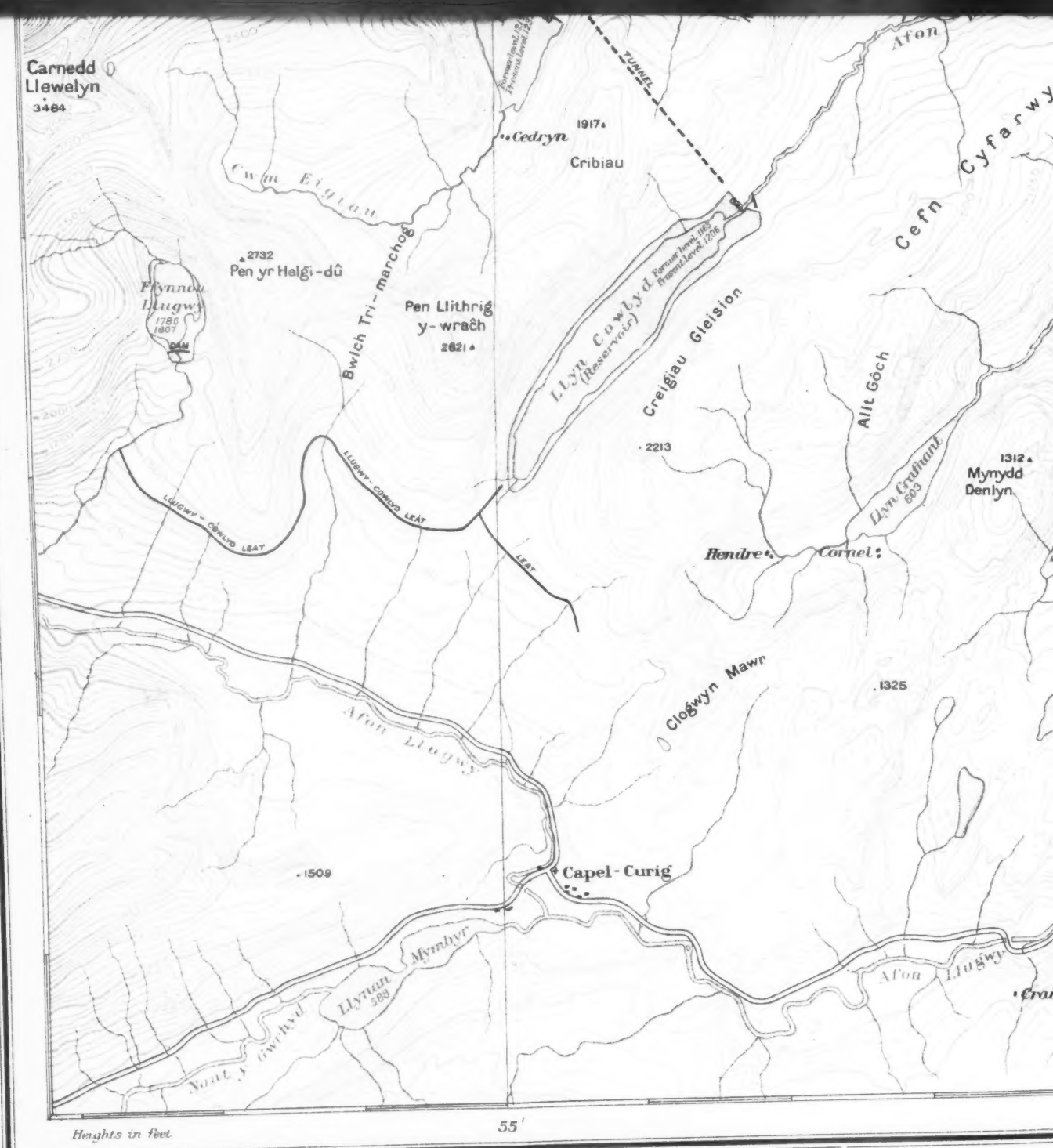
nd W.H. Wilcockson, M.A., F.G.S.





Heights in feet

55'

This map is based on the 1 inch Ordnance Survey

Scale :- 1 : 40,000

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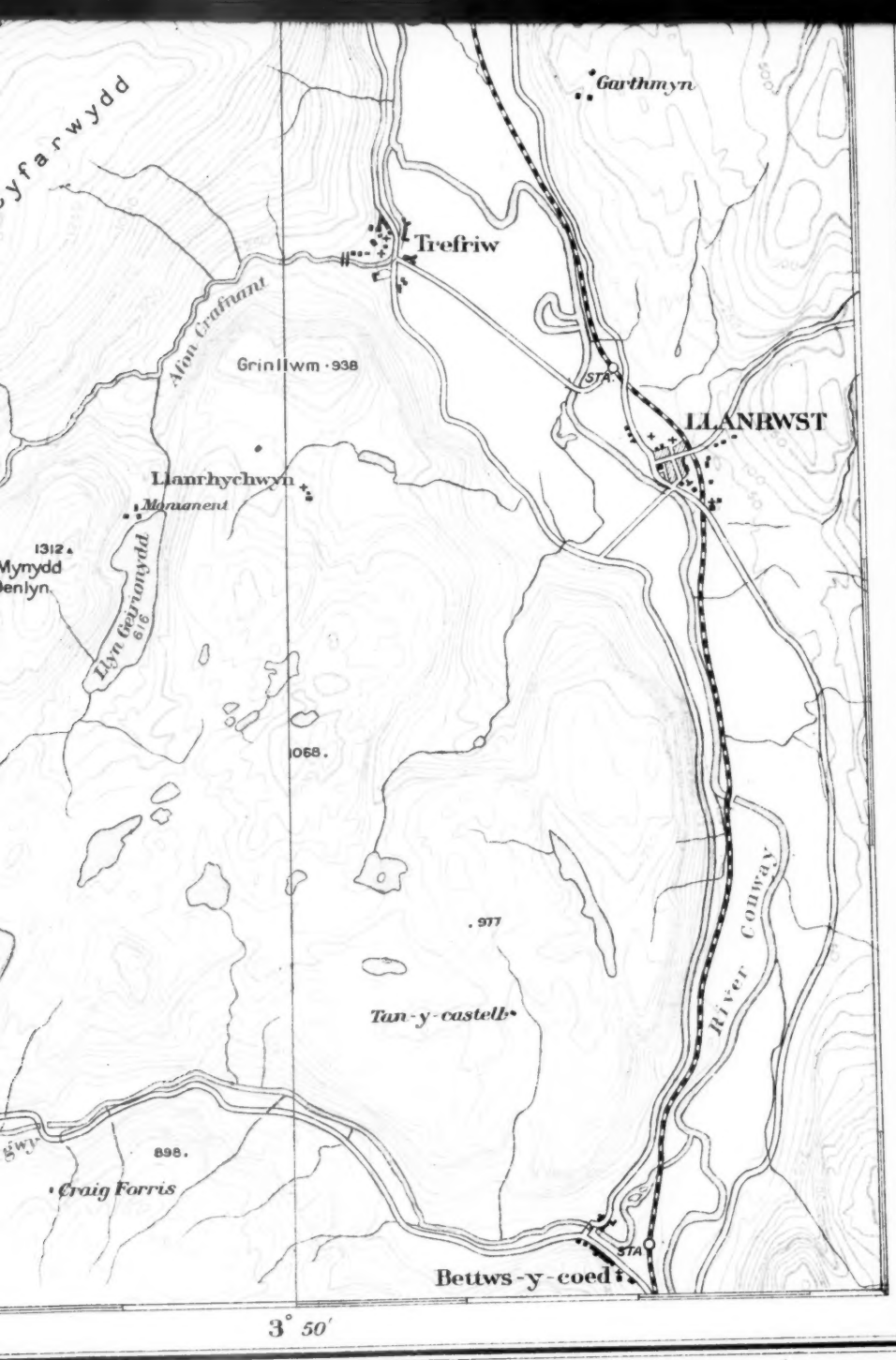
Miles

Published by the Royal Geographical Society



PORTH LLŴYD FLOOD.

Fearnsides & Wilcockson.

Society

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